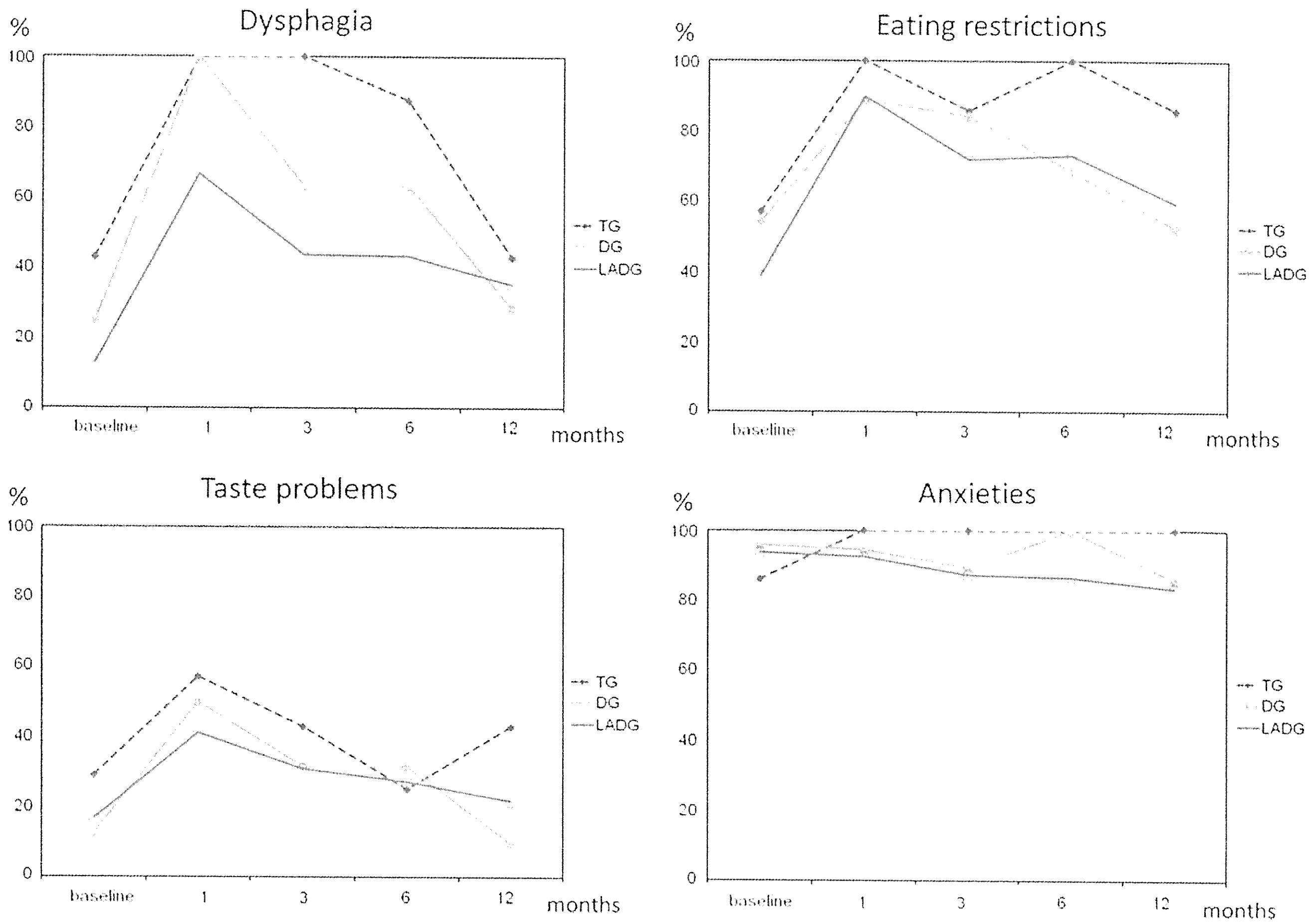

Fig. 4 Percentage of symptomatic patients in the EORTC QLQ-STO22: comparison between TG, DG, and LADG. There were longitudinal changes in the proportion of symptomatic patients in regard to dysphagia, eating restrictions, taste problems, and anxieties

Second, we made comparisons between the three commonly performed surgical procedures from a perspective of perioperative HRQOL. Although the extent to which the different types of resection or approach affect HRQOL remains poorly defined, it has been well documented that DG is superior to TG [18–21] and that laparoscopic surgery shows an advantage over open surgery for a few weeks after surgery [22–25]. The results obtained in the current study were in line with these observations and fulfilled our expectations. The difference between TG and DG was substantial in the physical functioning, role functioning, appetite loss, and eating restrictions scales. It is of note that the sample size of the TG group was too small for any meaningful comparison with other procedures. In addition, marked differences in the background (e.g., sex, age, incidence of combined resection) were observed between TG and the other procedures. Comparison between TG and other procedures must therefore be considered at best as referential data.

LADG was superior to DG in most of the items for up to 3 months after surgery, but the difference was not long-lasting with the exception of physical functioning. This comparison is heavily biased by the fact that LADG was performed in patients with a preoperative diagnosis of early-stage cancer, whereas patients undergoing DG suffered from more advanced disease. In addition to the difference in the extent of nodal dissection, a large proportion of patients with stage II–III cancer were given postoperative adjuvant chemotherapy. This is a weakness inherent to and inevitable in a single-institution study by investigators conducting exemplary clinical practice in Japan because a laparoscopy-assisted approach has been approved only for stage IA and IB gastric cancer in the Japanese Guidelines for Treatment of Gastric Cancer; in contrast, phase III evidence exists for delivering postoperative chemotherapy to patients with stage II–III disease. We noted with interest, however, that despite the large difference in the background in favor of laparoscopic surgery the difference between the approaches reconciled in the long term and remained noticeable only in physical functioning and fatigue. It remains compelling, therefore, to make a comparison between LADG and DG among patients of a similar clinical stage. Kim et al. measured HRQOL using EORTC QLQ-C30 and STO22 in their randomized trial comparing the two approaches, and reported on the significant superiority in several of the scales during an observation period of up to 3 months after surgery [26]. An important issue is whether such differences in HRQOL continue in the long term. The current study suggests that the marked differences between the two approaches are unlikely to persist at 12 months postoperatively.

Conclusions

We have concluded that the EORTC QLQ-C30 and QLQ-STO22 suggested some differences in HRQOL among surgical procedures for gastric cancer. Our main goal in this study was to fathom how useful these questionnaires are and whether the HRQOL thus measured could be used as endpoints in our future studies. As this goal was fulfilled, a nonrandomized prospective study to compare HRQOL between the laparoscopic and open approach for early-stage gastric cancer is currently ongoing. Our future goal in this series of studies is primarily to evaluate the benefit of the laparoscopic approach from the viewpoint of HRQOL.

Conflict of interest None.

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ORIGINAL ARTICLE

Nutritional recovery after open and laparoscopic gastrectomies

Shavkat Abdiev · Yasuhiro Kodera · Michitaka Fujiwara · Masahiko Koike · Goro Nakayama · Norifumi Ohashi · Chie Tanaka · Junichi Sakamoto · Akimasa Nakao

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Abstract
Background The aim of this study was to evaluate longitudinal changes in body composition after laparoscopic and open gastrectomies for gastric cancer.
Methods Body mass, arm muscle mass, leg muscle mass, and fat mass were measured by performing a bioelectrical impedance analysis using a "Bodyscan" body composition analyzer (HXE19-JA; Konami, Tokyo, Japan) in 41 patients who had undergone gastrectomy: 14 patients underwent open distal gastrectomy, 8 patients underwent open total gastrectomy, and 19 patients underwent laparoscopy-assisted distal gastrectomy. All measurements were obtained preoperatively and at 1, 3, and 6 months after the operation.
Results Fat mass decreased significantly throughout the 6-month period after distal gastrectomy and until 3 months after the laparoscopic surgery, while similar reductions in the total muscle mass and limb muscle mass were observed only in the first month after operation for all three groups. Patients with the laparoscopic approach had completely regained muscle mass at 6 months postoperatively.
Conclusion Both fat and muscle mass reductions were responsible for the body weight loss during the first postoperative month, whereas loss of fat mass contributed to further weight loss after that period. Enhanced recovery of muscle mass at 6 months after laparoscopic surgery suggests the benefit of this surgery, among other factors.

Keywords Body composition · Gastric cancer · Laparoscopic gastrectomy

S. Abdiev · Y. Kodera (✉) · M. Fujiwara · M. Koike · G. Nakayama · N. Ohashi · C. Tanaka · A. Nakao
Department of Surgery II, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, Aichi 466-8550, Japan
e-mail: ykodera@med.nagoya-u.ac.jp

J. Sakamoto
Department of Medical Administration, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, Aichi 466-8550, Japan

Introduction

Body composition is substantially affected by gastrointestinal surgery, and a certain period of time is needed for recovery. Significant changes in nutritional status shortly after distal gastrectomy have been demonstrated by Katsube et al. [1]. The laparoscopic approach is considered to be minimally invasive, is considered to result in better short-term outcome [2–5], and is hoped to be oncologically feasible even for advanced gastric cancers [6]. One of the advantages of laparoscopic gastrectomy was reported to be the prevention of overt weight loss, which had generally been explained in terms of decrease in protein mass rather than fat mass [7]. Another study has demonstrated selective loss of fat mass during the first 6 months after open gastrectomy, with a minor decrease of arm circumference [8]. There have been no other longitudinal studies evaluating changes in the composition of the body and extremities after gastrectomy.

The main goal of this study was to observe the trends in muscle and fat masses during the first 6 months after various types of gastrectomies.

Methods

Patients

Forty-one patients with resectable gastric cancer who underwent gastrectomy and were followed for 6 months were analyzed. Twenty-two patients whose cancer was diagnosed to have penetrated as far as the subserosa or deeper were operated by conventional open surgery with D2 lymph node dissection; total gastrectomy (TG) was performed in eight patients and distal gastrectomy (DG) in 14. Roux-en-Y reconstruction was used routinely for this population. Twenty-four patients with the preoperative diagnosis of up to T2 stage gastric cancer underwent laparoscopy-assisted distal gastrectomy (LADG) with D1–D2 lymph node dissection. Billroth I reconstruction was selected for 19 patients. Five patients with preoperative reflux symptoms or extraordinarily small residual stomach underwent Roux-en-Y reconstruction, were considered as atypical cases, and were excluded from this study. Details of the surgical procedures have been reported previously [9–11]. Postoperative adjuvant chemotherapy with S-1 [12] was delivered to 10 patients treated by DG, 3 patients treated by TG, and one patient treated by LADG. Another 3 patients in the TG group received postoperative chemotherapy with S-1/cisplatin (CDDP) and another patient was treated with chemoradiation. Parenteral nutrition was not introduced after surgery in any of the patients.

Measurements of body composition

Measurements of body composition were performed at the baseline (preoperatively) and at 1, 3, and 6 months after the surgery. Body weight, muscle mass (total mass and upper and lower limb mass), and fat mass (total mass and upper and lower limb mass) were measured using segmental multifrequency bioelectrical impedance analysis performed with the "Bodyscan" HXE19-JA analyzer (Konami, Tokyo, Japan) after obtaining written informed consent from the patients. The height and the waist circumference of each patient were measured before each measurement as parameters that are mandatory for calculating body composition data. Patients with installed pacemakers and those with severe cardiac arrhythmia were not eligible for the study.

Statistical analysis

General linear models of repeated measures were used for longitudinal analysis. Results are presented in delta values with 95% confidence intervals (CIs) between two time points. A p value of <0.05 was considered to be statistically significant. Statistical analysis was carried out using an SPSS software package (version 15; SPSS, Chicago, IL, USA).

Results

Patient demographics and tumor stages are presented in Table 1. As has been recommended in the Japanese treatment guidelines for gastric cancer, laparoscopic surgery was indicated for patients with early-stage cancer. The oncological background of patients who underwent LADG and those treated by open surgery was, therefore, completely different, along with the method of reconstruction.

Patients demonstrated a significant body weight loss of 5.55 kg (95% CI 3.81–7.30 kg) during the first month after DG, due to decreases in both the fat (2.08 kg, 95% CI 0.70–3.45 kg) and muscle masses (2.18 kg, 95% CI 0.77–3.59 kg) (Table 2; Figs. 1, 2, 3). The muscle masses of the upper and lower extremities also decreased by significant margins [0.37 kg (95% CI 0.07–0.67 kg) and 1.13 kg (95% CI 0.33–1.94 kg)] (Table 2; Figs. 4, 5). After this period, the body weight loss mostly reflected a consistent decrease in the fat mass, while the muscle mass stabilized and even showed a tendency to recover. In the patients with TG, significant losses in the body fat component and the muscle masses of the total body and the upper and lower extremities were observed during the first month [2.40 kg (95% CI 0.59–4.21 kg), 2.30 kg (95% CI 0.27–4.33 kg), 0.29 kg (95% CI 0.16–0.41 kg), and 1.38 kg (95% CI 0.26–2.51 kg), respectively]. The trend of losing the fat mass went on for 6 months and the trend of losing muscle mass lasted for 3 months, although the differences in fat mass between 3 and 6 months postoperatively and in the muscle between 1 and 3 months were not significant, probably due to the small sample size. In the first month after the LADG, the extent of reduction in the fat mass was 1.87 kg (95% CI 1.02–2.73 kg), along with a less prominent loss of muscle mass of 1.11 kg (95% CI 0.60–1.61 kg). During this period, the leg muscle mass decreased by 0.57 kg (95% CI 0.13–1.01), while the decrease in the arm muscle mass was insignificant. Most notably, the patients started to regain body muscle mass after the first month, and an increase of 0.43 kg (95% CI 0.03–0.82) was observed by the third month. The total increase from the first to the 6 months postoperatively turned out to be significant, at 0.63 kg (95% CI 0.25–1.27 kg). Corresponding recovery was also observed in the lower limb muscle mass (0.44 kg, 95% CI 0.04–0.83 kg).

At 6 months postoperatively, the total postoperative changes in body composition after the DG and LADG consisted of fat mass reduction by 5.83 kg (95% CI 3.86–7.79 kg) and 5.40 kg (95% CI 3.56–7.24 kg), respectively. In addition, total muscle mass after the DG decreased by 1.59 kg (95% CI 0.51–2.67 kg), while no significant reduction in the muscle-related parameters at that time point were observed for the LADG group, due to the aforementioned recovery. After the TG, body weight reduction of 9.94 kg (95% CI 4.91–14.97 kg) was observed at the 6th postoperative month.

Table 1 Medical and demographic characteristics of patients

Characteristics	DG ($N = 14$)	TG ($N = 8$)	LADG ($N = 19$)
Age, years (± SD)	67.2 ± 10.1	58.13 ± 18.0	62.0 ± 10.9
Male	13 (92.9%)	6 (80.0%)	13 (68.5%)
Initial weight (kg ± SD)	63.38 ± 11.63	60.16 ± 13.06	58.75 ± 10.39
Initial fat mass (kg ± SD)	15.51 ± 3.39	12.11 ± 2.33	14.09 ± 3.37
Initial total muscle mass (kg ± SD)	20.04 ± 4.14	19.96 ± 3.71	18.52 ± 3.85
Initial arm muscle mass (kg ± SD)	2.80 ± 0.69	2.91 ± 0.55	2.78 ± 0.86
Initial leg muscle mass (kg ± SD)	8.83 ± 2.00	8.67 ± 1.84	7.93 ± 2.26
BMI			
Underweight <18	1 (7.1%)	0 (0.0%)	2 (10.5%)
Normal 18–24.9	8 (57.2%)	7 (87.5%)	15 (79.0%)
Overweight >25	5 (35.7%)	1 (12.5%)	2 (10.5%)
Tumor characteristics			
Tumor depth			
T1a/T1b	1/1	0	17/1
T2	4	0	1
T3	3	3	0
T4a/T4b	4/1	4/1	0
N factor			
N0	3	2	19
N1N2	11	6	0
Stage			
IA/IB	1/3	0	18/1
IIA/IIB	0/2	0/3	0
IIIA/IIIB/IIIC	0/4/1	1/1/0	0
IV	3	3	
Distant metastasis			
M0	0	6	19
M1	1	2	0
Maximal size (mm ± SD)	46.1 ± 25.2	59.4 ± 35.8	28.1 ± 17.2
Number of removed lymph nodes (± SD)	36.4 ± 14.2	46.0 ± 21.7	27.3 ± 11.2
Number of positive lymph nodes (±SD)	3.6 ± 1.1	8.4 ± 1.6	0

SD standard deviation, *DG* distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy, *BMI* body mass index

Discussion

This study is the first report of muscle dynamics after gastrectomy. Our goal was not to make comparisons, between different surgical procedures, of various parameters related to the body composition at each time point, but to observe trends in the nutritional status of the patients after each procedure. Through longitudinal measurements after surgery, interesting data were obtained to speculate on and discuss the process of recovery after major surgery. The total body weight changes observed in our study were due mainly to the change in fat mass, regardless of the type of surgery. In patients with DG and LADG, the loss in fat mass even exceeded the body weight loss at 1–3 months postoperatively, due at least partly to the recovery of muscle mass.

The two prominent mechanisms of fat metabolism, increased consumption and reduced restoring, lead to a profound decrease in fat mass. It is considered that a small gastric remnant (or total resection of the stomach), poor oral food intake, and impaired carbohydrate digestion after gastrectomy lead to insufficient glucose intake, with subsequent depletion of glycogen storage, resulting in loss of body fat mass. In addition, fat malabsorption following gastrectomy is well established to be due to a relative pancreatic insufficiency with low lipase secretion, due to rapid intestinal transit and vagotomic effects [13–15]. The anabolic phase after gastrectomy starts with adequate carbohydrate intake and digestion which initially lead to fat mass stabilization. There was at least a sign of stabilization after the third month for our LADG group, whereas loss of fat mass continued consistently throughout the 6 months of observation for the DG group (Fig. 2). Postoperative chemotherapy given almost exclusively to the DG and TG groups may also have been the cause of reduced food

Table 2 Body composition parameters (all in kg) after open and laparoscopic gastrectomies

	0–1 Month [95% CI]	1–3 Months [95% CI]	3–6 Months [95% CI]	0–6 Months [95% CI]
DG				
Body weight	*5.55 [3.81; 7.30]*	*1.48 [0.44; 2.51]*	1.16 [−0.06; 2.38]	*8.02 [6.04; 9.99]*
Fat	*2.08 [0.70; 3.45]*	*1.91 [0.48; 3.34]*	*1.53 [0.42; 2.65]*	*5.83 [3.86; 7.79]*
Muscle	*2.18 [0.77; 3.59]*	−0.23 [−0.86; 0.40]	−0.21 [−1.18; 1.61]	*1.59 [0.51; 2.67]*
Arm muscles	*0.37 [0.07; 0.67]*	−0.02 [−0.11; 0.06]	0.02 [−0.25; 0.29]	*0.25 [0.02; 0.47]*
Leg muscles	*1.13 [0.33; 1.94]*	−0.10 [−0.37; 0.16]	0.20 [−0.59; 1.00]	0.89 [0.27; 1.52]
TG				
Body weight	*6.41 [4.12; 8.71]*	2.86 [−0.87; 6.59]	0.47 [−3.84; 4.77]	*9.94 [4.91; 14.97]*
Fat	*2.40 [0.59; 4.21]*	2.63 [−0.73; 5.99]	0.80 [−2.51; 4.11]	4.70 [−2.49; 11.88]
Muscle	*2.30 [0.27; 4.33]*	0.19 [−1.47; 1.85]	−1.07 [−3.75; 1.61]	2.28 [−3.93; 8.49]
Arm muscles	*0.29 [0.16; 0.41]*	−0.09 [−0.34; 0.16]	−0.12 [−0.78; 0.53]	0.24 [−0.17; 0.65]
Leg muscles	*1.38 [0.26; 2.51]*	0.12 [−1.21; 1.45]	−0.29 [−1.06; 0.47]	1.63 [−1.41; 4.67]
LADG				
Body weight	*3.75 [2.81; 4.70]*	*1.64 [0.18; 3.09]*	0.17 [−1.01; 1.34]	*6.10 [3.83; 8.37]*
Fat	*1.87 [1.02; 2.73]*	*2.74 [1.41; 4.08]*	0.30 [−0.66; 1.26]	*5.40 [3.56; 7.24]*
Muscle	*1.11 [0.60; 1.61]*	*−0.43 [−0.82; −0.03]*	−0.17 [−0.53; 0.19]	0.58 [−0.22; 1.38]
Arm muscles	0.10 [−0.24; 0.44]	−0.13 [−0.47; 0.22]	0.06 [−0.10; 0.22]	0.36 [−0.02; 0.74]
Leg muscles	*0.57 [0.13; 1.01]*	−0.07 [−0.24; 0.10]	−0.17 [−0.52; 0.17]	0.18 [−0.44; 0.81]

Italicized values are statistically significant ($p < 0.05$), negative values denote increase in the body composition parameters

CI confidence interval, *DG* distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

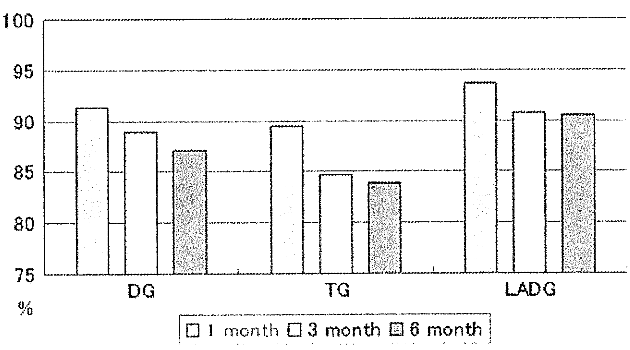

Fig. 1 Body weight expressed as a percentage of the preoperative value at 1, 3, and 6 months after surgery. *DG* Distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

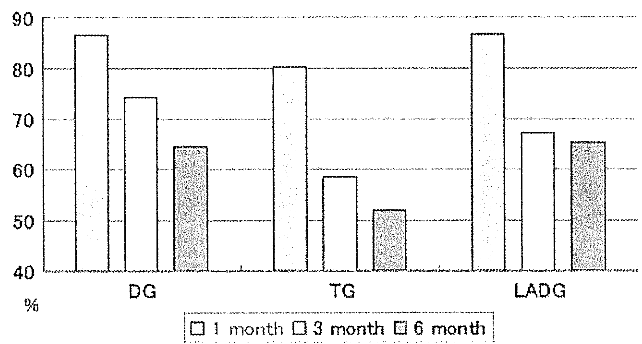

Fig. 2 Total fat mass expressed as a percentage of the preoperative value at 1, 3, and 6 months after surgery. *DG* Distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

intake, through loss of appetite. It is not possible at this time to analyze how each of these factors independently affected the outcome.

Low gastric enzyme levels and intestinal bacterial overgrowth are implicated in protein maldigestion [16–18], along with the altered ratio of serum concentrations of essential and branched-chain amino acids reported after gastrectomy which may predispose to muscle atrophy [19]. In addition, muscle mass after surgical intervention could also be affected by the patient's physical activity. The perioperative loss in total muscle mass may have reflected both poor nutritional status and lack of physical activity, and the condition was quite similar for all groups in our study. The leg muscle mass reduction was also significant in all groups and may have reflected patients' postoperative in-bed immobility. However, both the total muscle mass and leg muscle mass showed remarkable recovery 3 months after the operation in the LADG group. Given that nutritional recovery in terms of fat mass had not been achieved at 6 months postoperatively even for the LADG group, the recovery of the muscle mass may have been due exclusively to near-complete recovery in terms of physical activity.

There is no doubt that factors such as the type of reconstruction, extent of lymph node dissection, and postoperative adjuvant chemotherapy affect outcomes after

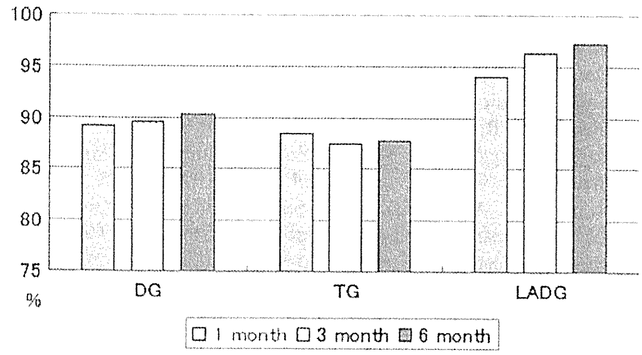

Fig. 3 Total muscle mass expressed as a percentage of the preoperative value at 1, 3, and 6 months after surgery. *DG* Distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

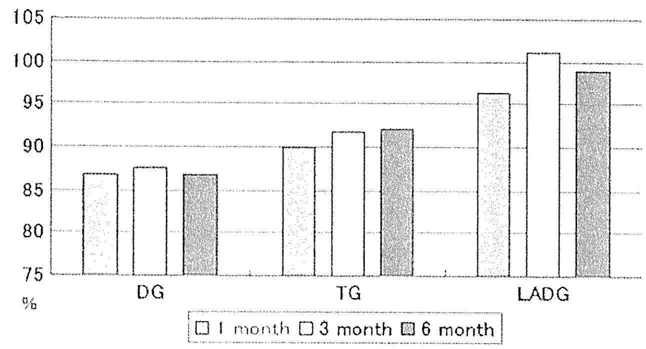

Fig. 4 Arm muscle mass expressed as a percentage of the preoperative value at 1, 3, and 6 months after surgery. *DG* Distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

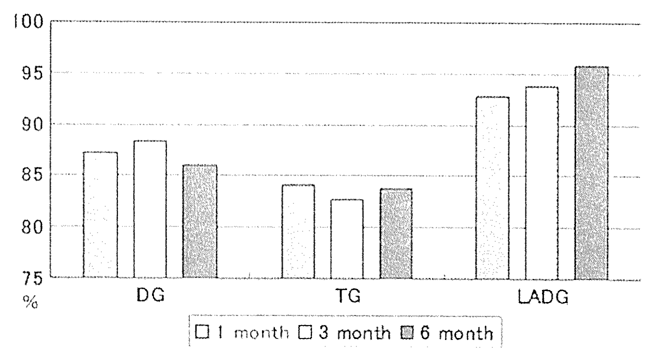

Fig. 5 Leg muscle mass expressed as a percentage of the preoperative value at 1, 3, and 6 months after surgery. *DG* Distal gastrectomy, *TG* total gastrectomy, *LADG* laparoscopy-assisted distal gastrectomy

surgery. Earlier resumption of food intake with preserved duodenal transit after LADG may have contributed to early nutritional recovery in our patients who had this procedure [20, 21]. More extended lymph node dissection performed for the DG and TG groups, with greater damage to the celiac nerve plexus, might have affected the postoperative digestive function more seriously. Perioperative chemotherapy, also given almost exclusively to the TG and DG groups, is expected to have had adverse effects on the nutritional status. Thus, the differences observed between the groups in the present study cannot be attributed solely to the operative approach. We were unable to analyze the effect of each of these factors, due to the retrospective and non-randomized nature of the study and the limited number of patients. Evaluation of a greater number of patients with similar backgrounds treated by different approaches is needed to confirm the speculations arising from this study.

In conclusion, after gastrectomy, all patients demonstrated loss of fat and muscle masses during the first postoperative month, regardless of the type of gastric resection or the operative approach. After DG, patients showed a continuous reduction of fat mass during the 6 months of follow-up, whereas recovery was observed 3 months after LADG. In addition, the recovery of muscle mass at 3 months after LADG was remarkable. While more vigorous programs for nutritional support may be warranted after gastric cancer surgery, minimally invasive surgery may facilitate recovery in terms of physical activities.

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Conflict of interest The authors declare that there is no conflict interest.

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Laparoscopy-assisted pylorus-preserving gastrectomy: a matched case–control study

Norimitsu Tanaka · Hitoshi Katai · Makoto Saka · Shinji Morita · Takeo Fukagawa

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Abstract
Background Pylorus-preserving gastrectomy (PPG) has been widely accepted as the standard treatment for early gastric cancer, and the laparoscopic approach has been gradually introduced. The aim of this study is to investigate the short-term outcome of laparoscopy-assisted PPG (LAPPG) in comparison with open PPG (OPPG).
Methods Between April 2006 and May 2009, a cohort of 418 patients with early gastric cancer in the middle third of the stomach underwent PPG, and 90 of the LAPPG patients and 90 of the OPPG patients among them were matched for sex, age, and body mass index. The outcomes of the patients in the two groups were then compared.
Results Operation time was significantly longer in the LAPPG group than in the OPPG group (270 vs. 195 min, $P < 0.001$), and there was significantly less blood loss in the LAPPG group than in the OPPG group (29 vs. 97 ml, $P < 0.001$). The overall incidence of surgery-related complications in the two groups was similar (8.9 vs. 11.1%). The proportion of patients who used analgesics after postoperative day 5 was significantly lower in the LAPPG group than in the OPPG group (35.6 vs. 61.1%, $P = 0.001$). There was no significant difference between the two groups in the interval between surgery and resumption of oral feeding, the interval between surgery and first flatus, number of patients with body temperature of 38°C or more, or length of hospital stay.
Conclusions LAPPG can be performed safely in terms of short-term outcome.

N. Tanaka · H. Katai (✉) · M. Saka · S. Morita · T. Fukagawa
Gastric Surgery Division, National Cancer Center Hospital,
5-1-1 Tsukiji, Chuo-ku, Tokyo 104-0045, Japan
e-mail: hkatai@ncc.go.jp

Keywords Laparoscopic surgery · Pylorus-preserving gastrectomy · Gastric cancer · Matched case-control study

Pylorus-preserving gastrectomy (PPG) has been widely accepted as a function-preserving surgery for early gastric cancer located in the middle third of the stomach. We reported finding that PPG was a safe operation that was associated with an excellent survival outcome and low postoperative morbidity rate [1]. We also reported finding that PPG provided clear advantages over distal gastrectomy in terms of patients' quality of life [2].

The laparoscopic approach is now being used with the aim of achieving minimally invasive therapy for early gastric cancer. PPG requires delicate surgical technique to preserve the pyloric branch of the vagal nerve and the infrapyloric vessels as a means of maintaining good pyloric function [1]. However, such delicate technique may be difficult to perform laparoscopically because of limited maneuverability of the instruments, and, as a result, the morbidity after laparoscopy-assisted PPG (LAPPG) may be higher than after PPG through an open approach (OPPG).

The aim of this study is to compare the short-term outcomes of patients who underwent LAPPG and OPPG during the same period.

Patients and methods

Between April 2006 and May 2009, 418 patients underwent PPG at the National Cancer Center Hospital, Tokyo, Japan. PPG is used to treat patients with a tumor that has been histologically confirmed to be adenocarcinoma, has been diagnosed clinically as early gastric cancer, and is located in the middle third of the stomach and more than 4.0 cm from the pylorus. Of the 418 patients, 99 had undergone LAPPG and 319 had undergone OPPG.

Patient selection

Whether a patient was treated by LAPPG or OPPG was decided by patient request or by attending surgeon preference. Patients with a greater volume of intra-abdominal fat, such as middle-aged or obese males, tended to have undergone OPPG; to reduce this selection bias, this study was designed as a matched case–control study. Patients who had undergone LAPPG (cases) and patients who had undergone OPPG (controls) were matched for sex, age (±5 years), and body mass index (BMI; ±1 kg/m^2). When more than one patient was a match, the patient whose date of surgery was closest was selected.

Nine patients (9.0%) who were originally in the LAPPG group were excluded from the study: two (2.0%) because conversion to OPPG was necessary because of severe adhesion and limited surgical margin, and seven (7.0%) because they could not be matched with a patient in the OPPG group. As a result, we compared 90 patients who underwent LAPPG with 90 matched patients who underwent OPPG during the same period.

Clinical data

Clinical and pathological data according to the *Japanese Classification of Gastric Carcinoma* [3] were collected and compared between the LAPPG group and the OPPG group.

Morbidity and mortality were also compared between the two groups. Gastric stasis was diagnosed when a routine postoperative upper gastrointestinal (GI) series showed that the contrast medium did not pass freely into the duodenum or when the patient had severe symptoms requiring no oral intake and intravenous fluid support for more than 24 h. Pancreatic fistula was diagnosed when fluid with high amylase concentration and infection was drained from the peripancreatic area for more than 7 days. Anastomotic leakage was diagnosed radiographically by an upper GI series. Wound infection was diagnosed when a bacterial culture of fluid discharged from the surgical wound yielded a pathogen.

Surgical procedures

PPG was performed as described previously [1]. The LAPPG procedure consisted of gastric transection and anastomosis through an upper midline skin incision (under 6 cm). When a skin incision longer than 6 cm was required, the procedure was considered to be OPPG. Continuous analgesia through an epidural catheter was performed during the first 3 days after surgery.

Table 1 Patient characteristics

	LAPPG (n = 90)	OPPG (n = 90)
Sex[a]		
Male/female	25/65	25/65
Age[a]		
Median (years)	57	56.5
Range (years)	26–79	26–79
Body mass index[a]		
Median (kg/m^2)	20.7	20.7
Range (kg/m^2)	15.6–25.4	15.9–26.1
ASA classification		
I	52	57
II	37	33
III	1	0
IV	0	0
Prior abdominal surgery	17	15
Tumor size		
Median (mm)	22	25
Range (mm)	1–110	2–85
Depth of invasion (pathological)		
Mucosa	50	47
Submucosa	39	42
Muscle	0	1
Subserosa	1	0
Serosa	0	0
Lymph node metastasis (pathological)		
N0	84	83
N1	6	5
N2	0	2

[a] Matched parameters

ASA American Society of Anesthesiologists

Statistical analysis

SPSS version 17.0 software (SPSS, Chicago, IL, USA) for Windows was used to perform statistical analyses. Baseline characteristics were compared by Mann–Whitney U-test for continuous variables, and the chi-square test was used for categorical variables. P values less than 0.05 were considered significant.

Results

Patient characteristics

There were no significant differences between the groups in patient characteristics, including the pathological findings in the tumor (Table 1).

Table 2 Surgical outcome

	LAPPG ($n = 90$)	OPPG ($n = 90$)	*P*
Operation time			<0.001
Median (min)	270	195	
Range (min)	165–400	92–295	
Blood loss			<0.001
Median (ml)	29	97	
Range (ml)	1–253	5–443	
No. of resected lymph nodes			0.428
Total	32	32	
Range	11–79	9–70	

Surgical outcome

Operation time was significantly longer in the LAPPG group than in the OPPG group, and there was significantly less blood loss in the LAPPG group than in the OPPG group. The number of lymph nodes resected in the two groups was similar (Table 2).

Postoperative morbidity

The incidence of surgery-related complications was 8.9% (8/90) in the LAPPG group and 11.1% (10/90) in the OPPG group. The incidence of the most frequent complication, gastric stasis, was 6.7% in the LAPPG group and 5.6% in the OPPG group (difference not significant). The incidence of wound infection was slightly lower in the LAPPG group (1.1%) than in the OPPG group (4.4%), although not statistically significantly so. Complications that required reoperation or computed tomography (CT)-guided drainage occurred in two patients (2.2%) in the LAPPG group (pancreatic fistula in both patients) and in three patients (3.3%) in the OPPG group (pancreatic fistula, anastomotic leak, and major bleeding in one patient each) (Table 3).

Table 3 Postoperative morbidity

	LAPPG ($n = 90$)	OPPG ($n = 90$)
Gastric stasis	6 (6.7%)	5 (5.6%)
Pancreatic fistula	2 (2.2%)	2 (2.2%)
Anastomotic leakage	0	1 (1.1%)
Postoperative bleeding	0	1 (1.1%)
Pneumonia	1 (1.1%)	1 (1.1%)
Wound infection	1 (1.1%)	4 (4.4%)

Some patients had more than one complication

Postoperative short-term clinical outcome

The proportion of patients who required analgesics after postoperative day (POD) 5 was significantly smaller in the LAPPG group than in the OPPG group. There was no significant difference between the two groups in the interval between surgery and resumption of oral feeding, the interval between surgery and first flatus, number of patients with body temperature of 38°C or more, or length of hospital stay (Table 4).

Discussion

LAPPG operation time was significantly longer than OPPG operation time, a finding that was consistent with previous reports [4–6]. PPG requires delicate technique to preserve the nerves and vessels supplying the pylorus as a means of maintaining good pyloric function. During laparoscopic surgery these delicate techniques must be performed with instruments that have limited maneuverability, and, as a result, LAPPG takes longer than OPPG. On the other hand, intraoperative blood loss was less in the LAPPG group than in the OPPG group, probably because hemostasis is easy in the expanding view of laparoscopy.

The numbers of lymph nodes resected in the two groups in this study was similar, consistent with the reports by Hiki et al. [4] and Nunobe et al. [5]. LAPPG allowed sufficient lymphadenectomy because of good vision of the dry field on laparoscopy as well as OPPG.

Postoperative morbidity in the LAPPG group and OPPG group in this study was similar. The high incidence of postoperative gastric stasis is reported to be the greatest drawback of PPG, but LAPPG did not increase the incidence of gastric stasis.

In this study patients in the LAPPG group required analgesics after POD 5 less frequently than did patients in the OPPG group. The advantages of laparoscopic surgery over open surgery are a smaller abdominal incision, maintenance of a warm, moist operative field, and minimal organ manipulation [7, 8], and these advantages may reduce pain after surgery. On the other hand, there was no significant difference between the groups in the interval between surgery and resumption of oral feeding, the interval between surgery and first flatus, the proportion of patients with body temperature of 38°C or more, or length of hospital stay, variables previously reported to be shorter or smaller with the laparoscopic approach than the open approach [9–11]. The absence of significant differences in the interval between surgery and the resumption of oral feeding and length of hospital stay was attributable to the fact that the patients in this study were cared for according to a uniform clinical pathway after surgery. OPPG was

Table 4 Postoperative short-term clinical outcome

	LAPPG ($n = 90$)	OPPG ($n = 90$)	P
No. of patients who used analgesics after POD 5	32 (35.6%)	55 (61.1%)	0.001
Interval between surgery and resumption of oral feeding			0.126
Median (days)	4	4	
Range (days)	3–22	3–41	
Interval between surgery and first flatus			0.054
Median (days)	3	3	
Range (days)	2–5	2–6	
No. of patients with body temperature of 38°C or more			0.765
POD 1	40	46	
POD 2	18	18	
POD 3	4	2	
During hospitalization	46	49	
Length of hospital stay			0.702
Median (days)	11	11	
Range (days)	8–51	9–86	

POD postoperative day

performed by experienced surgeons who had performed at least 100 OPPG procedures before the introduction of LAPPG. Open surgery on the upper abdomen may not have increased the interval between surgery and first flatus or the proportion of patients with body temperature of 38°C or more, because if an experienced surgeon performs, minimal surgical stress without touching intestine was provided. Also, PPG itself provides little chance of touching small intestine. Therefore, the only advantage of LAPPG over OPPG in terms of short-term outcome may have been the smaller incision.

There was bias in this study despite the matched case–control design. The male-to-female ratio of Japanese gastric cancer patients is 2.0 and 24.0% of the patients are overweight (BMI > 25 kg/m^2) [12]. However, the subjects of this study tended to be thin and female patients (male/female: 25/65; overweight patients: 3/90; 3.3%). Since overweight was previously reported to increase the risk of surgical complications in patients undergoing gastrectomy [13], this study could not justify LAPPG for obese male patients.

The results of this study demonstrated that LAPPG can be performed safely in terms of short-term outcome. However, this study could not justify LAPPG for obese male patients. Since this study was a nonrandomized comparative study conducted at a single institution, a multicenter prospective study is needed to evaluate safety and efficacy of LAPPG. The Gastric Cancer Surgical Study Group of the Japan Clinical Oncology Group (GCSSG/JCOG) recently conducted a multi-institutional phase II trial (JCOG0703) to evaluate the safety of laparoscopy-assisted gastrectomy, including LAPPG, for early gastric cancer [14], and a phase III study is planned.

In conclusion, LAPPG could be performed safely in this matched case–control study, but a multicenter prospective trial is needed to confirm the results.

Disclosures Authors N. Tanaka, H. Katai, M. Saka, S. Morita, and T. Fukagawa have no conflicts of interest or financial ties to disclose.

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Measurement of Inserting Motion of Bladeless Trocar at Real Surgery for Development of a Virtual Training System for Initial Trocar Placement in Laparoscopic Surgery

Takuya Watanabe[1], Michitaka Fujiwara[1], Yasuhiro Kodera[1], Masamichi Sakaguchi[2], Hiroki Hidaka[2], Hideo Fujimoto[2] and Akimasa Nakao[1]
[1]Department of Surgery II, Nagoya University Graduate School of Medicine, Nagoya, Japan
[2]Nagoya Institute of Technology, Nagoya, Japan
Corresponding Author: Takuya Watanabe, Department of Surgery II, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya, Aichi 466-8550, Japan
Tel.: +81527442250, Fax: +81527442245, E-mail: watanabetakuya@med.nagoya-u.ac.jp

KEY WORDS:
Optical view method; Trocar inserting motion; Training system; Virtual reality

ABBREVIATIONS:
U.S. Food and Drug Administration (FDA); Laparoscopic Pylorus Preserving Gastrectomy (LAPPG); Laparoscopic Distal Gastrectomy (LADG); Laparoscopic Total Colectomy (LATC); Laparoscopic Local Gastric Wedge Resection (LWR); Around the Navel (AN); Right Lower Quadrant of the Abdomen (RLQ); Left Side of the Abdomen (LS); Right Side of the Abdomen (RS); Left Lower Quadrant of the Abdomen (LLQ)

ABSTRACT

Background/Aims: The optical view method is an alternative to the open method as a laparoscopic entry technique, but it calls for a certain experience. Therefore we undertook the development of a training system for optical view method in initial trocar placement. For this purpose, kinetic data concerning insertion of a trocar were measured by means of non-invasive monitoring during actual surgery.
Methodology: We slotted force and motion sensors into an adapted trocar and measured the kinetic aspects of trocar insertion in terms of force and torque. The measurement was carried out at the time of the second and third trocar insertion by a single experienced surgeon.
Results: The measurement was carried out at 11 sites in 6 patients. We measured position, inserting force and inserting torque of the measuring trocar continuously. Mean maximum inserting force was 71.4N (range: 63.9-75.5N) at the perinavel port and 65.3N (range: 31.8-83.8N) at other sites. Mean maximum torque was 0.19Nm (range: 0.18-0.21Nm) at the perinavel port, and 0.23Nm (0.15-0.35Nm) at other sites. The number of rotations needed to penetrate the abdominal wall differed considerably among the patients.
Conclusion: In the measurement by an experienced operator, inserting force and torque data were consistent and generally did not depend on the patient characteristics or the site of puncture. Difficulty in penetration according to the physical characteristics of the patients was adjusted by differences in the number of rotations applied to the trocar.

INTRODUCTION

In recent years, laparoscopic surgery has been performed as a most popular version of minimally invasive surgery, and the number of cases of oncological surgery performed in Japan has increased exponentially. Laparoscopic surgery is considered to be beneficial to the patients, particularly regarding the short-term outcome, but can only be performed after the surgeons have received adequate education and training.

Initial trocar placement is the first challenging step in laparoscopic surgery that can lead to serious consequences, and is performed by various methods including Veress needle method (blind entrance), Hasson's open method and optical view method. In Japan, the open method has been most commonly performed since it does not need special training for those who have already established themselves as surgeons. However, skin incision tends to be longer than the diameter of the trocar, causing continuous leakage of carbon dioxide while the pneumoperitoneum is being maintained. This is often irritating for the surgeons and could prolong the operating time. In addition, the open method can be technically cumbersome, especially in obese patients.

In the optical view method, a bladeless trocar with a handle and blunt tip made of transparent plastic material is used. The laparocope is inserted into the trocar which a surgeon holds by the handle and inserts directly into the peritoneal cavity by applying a constant axial penetration force accompanied with rotations. The insertion is performed after making a small skin incision and while the abdominal wall is lifted upwards by the surgeons. During insertion, the blunt tip will progress by pushing the blood vessels aside rather than cutting into them, resulting in minimal hemorrhage from the abdominal wall. Since the tip is transparent, surgeons will be able to identify the abdominal wall layers as the laparoscope-containing trocar progresses through the wall. The penetrated structures such as rectal sheath are visualized as multi-layers of a ring that starts from the tip center and becomes enlarged before disap-

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pearing outside of the trocar. When the last ring known as the white ring enlarges and disappears, that ring represents the peritoneum and the surgeon will notice that the insertion is complete. When the surgeon becomes accustomed to the procedure and the direct visual identification of the abdominal wall layers, this method could be considered as a safe and time-sparing method for initial trocar placement (1). On the other hand, according to the database of the U.S. Food and Drug Administration (FDA), fatalities occur even when laparoscopists used optical trocars. Although designed to help avoid injury, these designs are not a substitute for adequate training or for the use of proper technique (2). A teaching leaflet has been created to facilitate surgeons in identifying the layers as the laparoscope-containing trocar penetrates through the abdominal wall. Currently, however, the only method to train a surgeon to insert the trocar with adequate force remains to be the hands-on training.

This situation prompted us to create a virtual reality simulator for trocar insertion using the optical view method. The training using virtual reality technology is different from training using animals or dummy models and has many advantages such as allowance for repeated usage and failed attempts (3-5). For this purpose, some basic data regarding the number of rotations and axial force needed to drive the bladeless trocar was necessary. However, little data measuring the entry force of trocar in animals or dummy models is available (6-9). In the current study, original data needed for development of the virtual abdominal wall model were accumulated using non-invasive monitoring of trocar insertion during actual laparoscopic surgery.

METHODOLOGY

System for measurement of kinetic data for trocar insertion

At first, we developed a non-invasive measuring system for trocar insertion at Nagoya Institute of Technology (**Figure 1**). We modified a 12mm disposable Optiview trocar (Ethicon Endo-surgery Cincinnati, OH, USA), and constructed a measuring trocar of 340mm length, containing the 6DOF force sensor (NANO sensor 5/4, BL Autotech, Ltd.) and receiver of the three dimensional motion tracking system (FASTRAK, Polhemus) (**Figure 2**). Through insertion of this trocar, the position of the trocar tip can be continuously tracked and recorded by the FASTRAK and kinetic data (force and torque) can be measured by the NANO sensor 5/4. Because the FASTRAK uses a magnetic field, the transmitter was placed as far from the surgical bed as possible.

Acquisition of kinetic data for trocar insertion during actual laparoscopic surgery

Since the measuring trocar cannot accommodate the laparoscope, insertion of a camera port was needed before insertion of the measuring trocar to ensure its safe placement under the laparoscopy. The measuring trocar was accordingly inserted as a second or third trocar. One experienced laparoscopic surgeon (M.F.) with experience of optical view method in more than 1,000 patients inserted the measuring trocar for all cases. This was because data had to be compared between patients with different body contour and between different sites of trocar insertion, and difference owing to the technique of the surgeon had to be minimized. This study was approved by the ethics committee of Nagoya University and written informed consent was obtained from all patients.

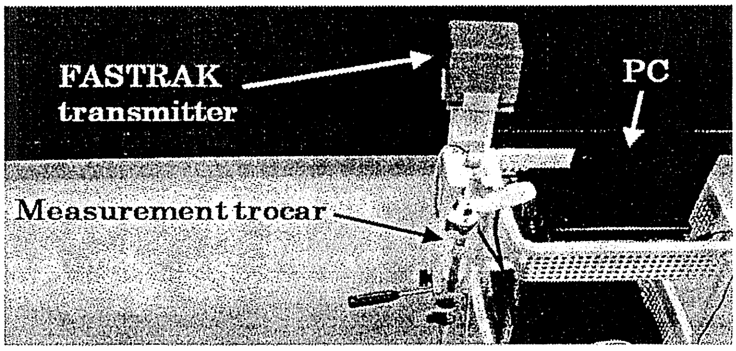

FIGURE 1 The inserting motion measurement system

RESULTS

Evaluation was performed at 11 sites in 6 patients. **Figure 3** shows an example of the pressure applied upon insertion of the trocar as monitored by NANO sensor 5/4. **Figure 4** shows an example of torque applied upon insertion as monitor by the same device. In this particular case, the maximum force was about 61N and maximum torque was about 0.26Nm. The time needed for insertion time was about 13 seconds.

Table 1 shows the summary of all cases. At the perinavel site, the mean maximum inserting force (N) was 71.4N (range: 63.9-75.5N) at the perinavel site and 65.3N (range: 31.8-83.8N) at the other port sites, with no significant difference between the two sites. No difference was observed between the individuals. The mean maximum torque (Nm) was 0.19Nm (range: 0.18-0.21Nm) at the perinavel site and 0.23Nm (range: 0.15-0.35Nm) at other sites, again, with no significant difference. Total number of rotations (twisting motion as the trocar penetrates through the abdominal wall) ranged from 11 to 33 and was variable among the individuals.

DISCUSSION

The authors have utilized optical view method for the laparoscopic entry in 1,300 cases of laparoscopic surgery since 1998. This method has its own training process and learning curve (10). Although this procedure is safe and practical, there are some pitfalls. One potential hazard is derived from inability to identify the position of the trocar tip through the simultaneously obtained endoscopic vision. In this case, the surgeon could keep driving the trocar when the tip is already in the abdominal cavity, causing visceral and vascular injuries. To avoid this serious problem, training to identify the abdominal wall layers, particularly the aforementioned white ring that represents the peritoneum, is mandatory. In addition, inadequate force to drive the trocar could lead either to an abrupt and unexpected penetration into the abdominal cavity and beyond, or to the inability to penetrate through either of the anatomical layers that constitute the abdominal wall. When the trocar is inappropriately guided, the trocar tip could slide on the surface of the fascia without penetrating through it. For these problems, training to exert adequate pressure to drive the trocar through each of the anatomical layers is necessary.

Abdominal wall dummy model does not imitate the layered structure of the abdominal wall with sufficient authenticity and is not suited for training optical view method where the inserting procedures should coordinate with the laparoscopic findings of the penetrating abdominal wall. Training using the animals is unsuitable due to the anatomical difference in which the swine, typically used for training, has smaller amount of subcutaneous fat and tough and thickened peritoneum that do not resemble the human abdominal wall. Thus, the authors opted for training by virtual reality simulators.

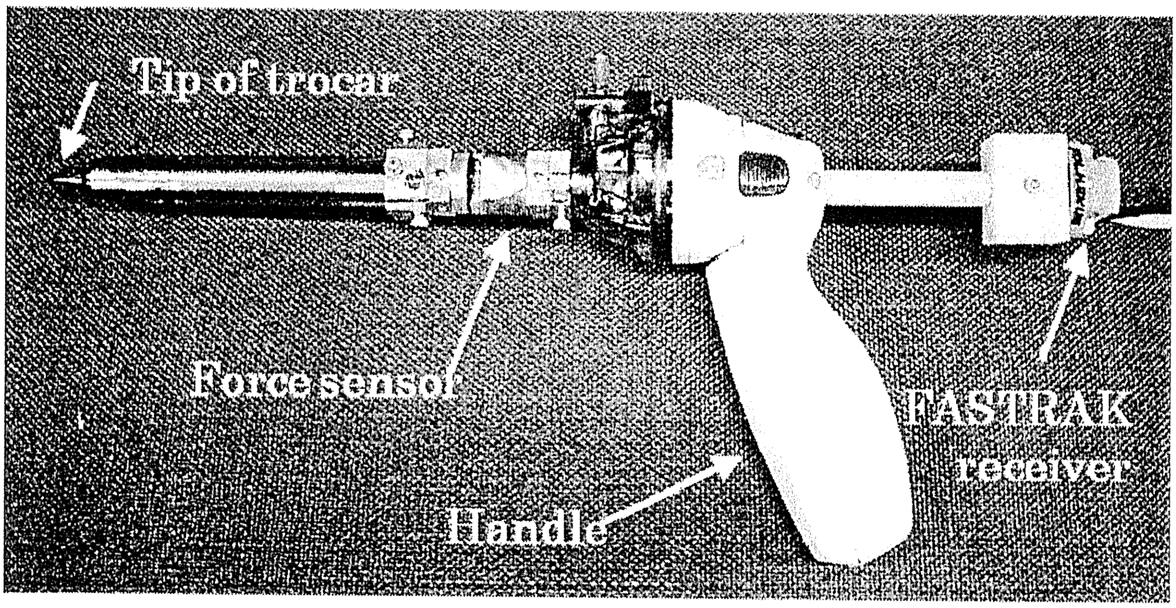

FIGURE 2 The reconstructed measuring trocar

TABLE 1 Summary of All Cases

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 5
age/gender	71M	63M	54M	67M	38F	69M
disease	Gastric cancer	Gastric cancer	Gastric cancer	Ulcertive colitis	Gastric GIST	Gastric cancer
operation	LAPPG	LADG	LAPPG	LATC	LWR	LADG
BMI	27.0	18.9	21.0	19.6	27.6	24.7
The first measurement site	AN	AN	AN	RLQ	AN	LS
Puncture time (S)	Record failure	13	10	10	20	13
maximum force (N)		75.54	72.54	83.02	73.59	61.27
maximum torque (Nm)		0.19	0.18	0.32	0.21	0.26
Total rotation		19	14	14	30	22
The second measurement site	RS	LS	LS	LLQ	LS	AN
Puncture time (S)	26	14	18	7	18	25
maximum force (N)	54.10	62.04	80.76	31.82	83.84	63.85
maximum torque (Nm)	0.15	0.15	0.35	0.09	0.30	0.18
Total rotation	26	23	24	11	31	33

LAPPG, Laparoscopic pylorus preserving gastrectomy; LADG, Laparoscopic distal gastrectomy; LATC, Laparoscopic total colectomy; LWR, Laparoscopic local gastric wedge resection; AN, Around the navel; RLQ, Right lower quadrant of the abdomen; LS, Left side of the abdomen; RS, Right side of the abdomen; LLQ, Left lower quadrant of the abdomen;

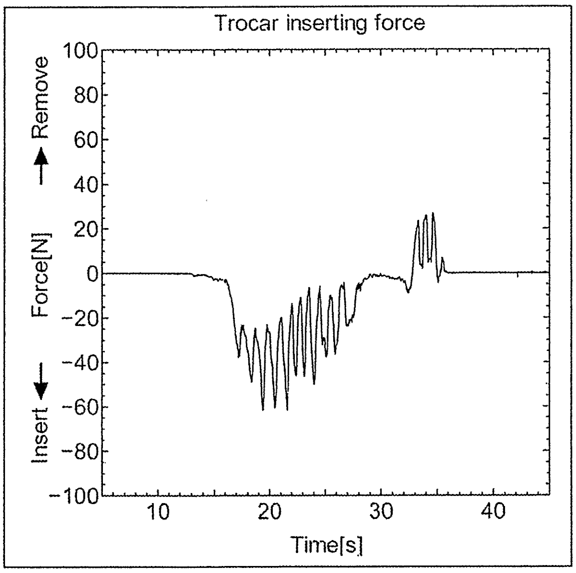

FIGURE 3 Inserting force data of trocar (Case 6)

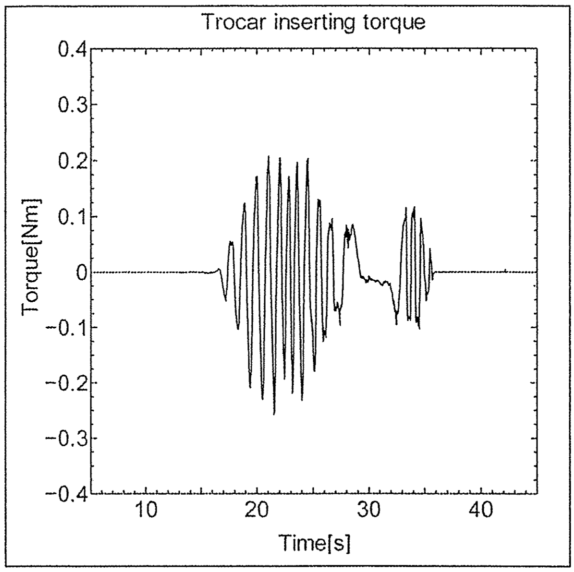

FIGURE 4 Inserting torque data of trocar (Case 6)

The most important data needed to create an original virtual training system were the kinetic profile of trocar insertion obtained from actual patients. Although similar data had been available, these originated from measurements using animals and dummy models. Data from humans have never been reported.

Through the current study, we have shown that the force needed to penetrate through the human abdominal wall is 60-70N. In addition, the force and torque needed for penetration did not in general differ significantly from patient to patient or according to the site of puncture. The only exception was a patient who had been under a high dose steroid therapy. The force needed for trocar insertion was outstandingly small at 31.8N. On the other hand, the number of twists needed depended more heavily on the patient and site of puncture. Thus, the amount of total workload needed for penetration of the abdominal wall, which should apparently be different according to the amount of subcutaneous fat, thickness of the muscles and durability of the fasciae that depend on the gender, age and condition of the patients, has been controlled not by force or torque but by the number of rotations a surgeon gives to the trocar.

This is the first data of the kinetic profile obtained from the human subjects and will be a valuable reference for creating a virtual training system. We are currently in the process of creating a new simulator which can be pre-adjusted to various patterns corresponding to patients with varying conditions. The current data also inform the surgeons that when they have difficulty inserting a trocar to a patient with particularly tough abdominal wall, they are adviced to penetrate through the abdominal wall not by putting extra strength, but by keeping the rotating motion of the trocar as long as needed with consistent appliance of their usual force.

There were two weaknesses in the current study. Firstly, the insertion procedure we evaluated was not for the initial trocar. Since the measuring trocar we had built for this study could not accommodate a laparoscope (**Figure** 2), we had to initially insert another trocar as a laparoscope port to observe while the measuring trocar was inserted. It was not ethical to attempt inserting the measuring trocar to a human subjects through blind access entry. The effect of the pneumoperitoneum that had been obtained at insertion of the measuring trocar is currently considered as negligible, since the actual first trocar insertion through the optical view method is performed by lifting the abdominal wall with a considerable strength. However, the first prototype of the simulator will have to be tested by several surgeons and receive their feedbacks for relevant adjustments before the simulator can be validated. Another weakness was that the information obtained through the laparoscope as the trocar penetrates through the abdominal wall was apparently not available to the surgeon who inserted the measuring trocar. Thus, the surgeon had to insert the measuring trocar without the real time knowledge as to which structure he is penetrating.

In conclusion, we obtained original data under the actual laparoscopic surgery for development of the virtual abdominal wall model. In the measurement by an experienced operator, inserting force and torque data were consistent and generally did not depend on the patient characteristics or the site of puncture. Difficulty in penetration according to the physical characteristics of the patients was adjusted by differences in the number of rotations applied to the trocar. Based on these data, we are planning to develop the training system which combines force feedback system with image display.

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Long-term outcome and survival with laparoscopy-assisted pylorus-preserving gastrectomy for early gastric cancer

Xiaohua Jiang · Naoki Hiki · Souya Nunobe · Tetsu Fukunaga · Koshi Kumagai · Kyoko Nohara · Hiroshi Katayama · Shigekazu Ohyama · Takeshi Sano · Toshiharu Yamaguchi

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Abstract
Background Laparoscopically assisted pylorus-preserving gastrectomy (LAPPG) is introduced as a function-preserving operation with minimal invasion for early gastric cancer (EGC). This study aimed to investigate the long-term outcome and survival with LAPPG.
Methods From January 2005 to July 2008, 188 patients with EGC underwent LAPPG. The surgical and long-term outcomes and survival were assessed retrospectively.
Results The accuracy of the preoperative EGC diagnosis was 92.6%. The median follow-up period was 38 months (range, 2–63 months). Two patients experienced gallstones, and three patients experienced a second primary EGC. One patient with T3N0 gastric cancer died of peritoneal metastasis, and four patients died of other causes. The overall 3-year survival rate was 97.8%, and the disease-specific 3-year survival rate was 99.3%.
Conclusions The LAPPG procedure is safe in terms of satisfactory long-term outcome and survival for patients with EGC in the middle third of the stomach.

Keywords Early gastric cancer · Laparoscopy-assisted pylorus-preserving gastrectomy · Long-term outcome

X. Jiang · N. Hiki (✉) · S. Nunobe · T. Fukunaga · K. Kumagai · K. Nohara · H. Katayama · S. Ohyama · T. Sano · T. Yamaguchi
Department of Gastroenterological Surgery, Gastroenterological Center, Cancer Institute Hospital, Japanese Foundation for Cancer Research, 3-10-6 Ariake, Koto-ku, Tokyo 135-8550, Japan
e-mail: naoki.hiki@jfcr.or.jp

X. Jiang
Department of General Surgery, Zhongda Hospital, Southeast University, Nanjing, China

In recent years, the number of early gastric cancer (EGC) cases has been increasing due to the development of mass screening and diagnostic procedures. In Japan, EGC represents more than 50% of all gastric cancers [1, 2]. Early gastric cancer has a low incidence of lymph node metastasis and excellent survival rates after surgical treatment, which has led to the frequent application of limited and less invasive operations such as endoscopic mucosal resection, segmental resection, and laparoscopically assisted gastrectomy [3].

Pylorus-preserving gastrectomy (PPG) with radical lymph node dissection has been applied as a limited surgical therapy for EGC [4]. Compared with conventional distal gastrectomy (CDG), PPG retains the pyloric ring and gastric function, which results in a lower incidence of postgastrectomy syndrome including dumping syndrome, bile reflux gastroesophagitis, weight loss, and nutritional deficit [5–7].

Laparoscopically assisted surgery is increasingly used for EGC because it is less invasive and offers a better postoperative outcome [8]. Laparoscopically assisted distal gastrectomy (LADG) has resulted in less pain, earlier postoperative recovery, shorter hospital stay, and better quality of life, whereas the curability and long-term survival have not differed between LADG and CDG [8, 9]. However, as an operation without preservation of the pyloric ring, postgastrectomy syndrome still remains a problem after LADG [10].

Laparoscopically assisted pylorus-preserving gastrectomy (LAPPG), as both a function-preserving and minimally invasive surgical technique, combines the merits of PPG and laparoscopic surgery. We have reported the feasibility and techniques of LAPPG previously [11–13]. Compared with conventional PPG, LAPPG had less intraoperative blood loss, shorter bowel function recovery, and shorter hospital stay [11–13].

We have previously reported the survival benefit of PPG shown in 94 LAPPG procedures for 305 patients with EGC [14]. However, little is known about the long-term outcome of LAPPG such as the occurrence of postoperative intestinal obstruction, gallstone, and remnant stomach cancer. The survival benefit of LAPPG itself also is unknown. In this study, we investigated the long-term outcome and survival benefit of PPG using only the laparoscopic approach for 188 patients with EGC.

Patients and methods

From January 2005 to July 2008, 188 patients with EGC diagnosed before surgery underwent LAPPG in the Department of Gastroenterological Surgery at The Cancer Institute Hospital, Tokyo, Japan. All the patients had a clinical diagnosis of mucosal or submucosal gastric cancer without lymph node metastasis (cT1, cN0) based on the results of gastric endoscopy, barium radiography, computed tomography, or endoscopic ultrasonography.

The indication for LAPPG was cT1, cN0 gastric cancer located in the middle one-third of the stomach more than 5 cm proximal to the pyloric ring and with a maximum diameter less than 5 cm. Patients who were candidates for endoscopic resection were excluded from the study. Nodal involvements were rechecked by routine intraoperative frozen-section diagnosis of lymph nodes from the dissected stomach specimen.

Surgical procedures

The LAPPG technique was performed according to procedures we have described previously [11, 12]. Lymph node stations corresponded to specific lymph node tiers named by the Japanese Classification of Gastric Carcinoma (JCGC) [15]. Dissection of the first-tier nodes (stations 1, 3, 4sb, 4d, and 6) was performed by D1 lymphadenectomy, whereas D1 + α lymphadenectomy involved station 7; D1 + β involved stations 7, 8a, and 9; and D1 + β + 11p involved stations 7, 8a, 9, and 11p. The lymph nodes at station 5 (suprapyloric) were routinely left intact. The infrapyloric vessels and the first branch of the right gastric artery were routinely preserved to maintain sufficient blood supply to the pyloric cuff. The hepatic and pyloric branches of the vagus nerve were routinely preserved, and the celiac branch of the vagus nerve was preserved when possible. The remaining procedures were the same as described previously [12].

The resected specimens were examined, and gross form, degree of N, and stage classification were scored according to JCGC [15]. Operation data and early postoperative outcome including complications were recorded. Early postoperative complications were defined as conditions occurring during the first 30 postoperative days that required reoperation, an additional procedure, or a prolonged hospital stay compared with routine practice [16].

Postoperative surveillance

All the patients were followed according to the established protocol at our hospital including medical history, physical examination, and laboratory studies such as tumor markers 1 and 3 months after operation, then every 6 months. At each visit, symptoms were recorded. Abdominal ultrasonography and computed tomography were performed every 6 months, and gastroscopy was performed each year. Vital statistics of all the patients were confirmed using data from follow-up charts. Occurrence of gallstone or remnant stomach cancer was recorded. Information about patients free of tumor recurrence and, when appropriate, the cause of death, also were recorded.

Statistical analysis

All data were analyzed on an intention-to-treat basis. Overall survival was calculated by the Kaplan–Meier method. Statistical analyses were performed using SPSS version 13.0 (SPSS Inc., Chicago, IL, USA).

Results

The 188 patients (109 men and 79 women) receiving LAPPG had a mean age of 58.2 years (range, 34–80 years)

Table 1 Clinical and pathologic characteristics of 188 patients undergoing laparoscopy-assisted pylorus-preserving gastrectomy (LAPPG)

Characteristic	Value
Age (years)[a]	58.0 ± 10.3 (34–80)
Sex (male/female)	109/79
Body mass index (kg/m^2)[a]	22.5 ± 3.1 (16.8–30.8)
Tumor location (U/M/L)[b]	2/170/16
Tumor size (cm)[a]	2.8 ± 1.4 (0.6–9)
Differentiation (differentiated/undifferentiated)	65/123
Depth of tumor invasion[c]	
Mucosa/submucosa	100/74
Muscle/subserosa/serosa	4/7/3
Nodal status (pN0/pN1/pN2)[c]	174/12/2
Pathologic staging (IA/IB/II/IIIA)[c]	164/15/8/1

[a] Values are mean ± standard deviation (range)

[b] U: Upper third of the stomach; M: Middle third; L: Lower third

[c] According to the Japanese Classification of Gastric Carcinoma