Surg Today (2017) 47:1274–1281
DOI 10.1007/s00595-017-1506-x

ORIGINAL ARTICLE

Safety and feasibility of laparoscopic gastrectomy for gastric cancer patients with a history of abdominal surgery

Kotaro Yamashita[1] · Yasuhiro Miyazaki[1] · Tsuyoshi Takahashi[1] · Yasunori Masuike[1] · Masaaki Motoori[2] · Yutaka Kimura[3] · Yukinori Kurokawa[1] · Tomoki Makino[1] · Makoto Yamasaki[1] · Kiyokazu Nakajima[1] · Shuji Takiguchi[1] · Masaki Mori[1] · Yuichiro Doki[1]

Received: 29 November 2016 / Accepted: 16 February 2017 / Published online: 20 March 2017

Abstract
Purpose To assess the safety and feasibility of laparoscopic gastrectomy (LG) for gastric cancer patients with a history of abdominal surgery (HAS).
Methods This retrospective study analyzed data collected from gastric cancer patients with HAS, who underwent LG between 2004 and 2015. We compared the clinicopathological features that correlated with conversion to open surgery and the development of severe postoperative complications (Clavien–Dindo classification of grade III or higher).
Results Of the 41 patients identified, 6 (14.6%) required conversion to open surgery. The incidence of conversion to open surgery was associated with a history of lower gastrointestinal tract surgery ($p=0.009$), attempted laparoscopic total gastrectomy ($p=0.002$), and excessive blood loss ($p<0.001$). Severe postoperative complications developed in six patients (14.6%). Although the development of complications was associated with high postoperative serum C-reactive protein, the type of past abdominal surgery was not significantly correlated with severe complications.
Conclusions LG was feasible for gastric cancer patients with a HAS, but for those with a history of lower abdominal surgery or those who require total gastrectomy, surgeons should carefully consider the indications for LG.

✉ Yasuhiro Miyazaki
ymiyazaki02@gesurg.med.osaka-u.ac.jp

[1] Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, 2-2 Yamadaoka, Suita, Osaka 565-0871, Japan

[2] Department of Gastroenterological Surgery, Osaka General Medical Center, Osaka, Japan

[3] Department of Surgery, Faculty of Medicine, Kinki University, Osaka, Japan

Keywords Gastric cancer · Laparoscopic gastrectomy · Previous abdominal surgery

Introduction

Since Kitano et al. [1] reported the first laparoscopy-assisted gastrectomy in 1994, many patients with early gastric cancer have been treated with laparoscopic procedures. Currently, the fourth version of the Gastric Cancer Treatment Guidelines in Japan recommends a minimally invasive procedure, such as laparoscopic distal gastrectomy, for clinical stage I gastric cancer [2–4]. Technical advances have also made laparoscopic gastrectomy (LG) feasible for advanced cancers, which require aggressive lymph node dissection or total gastrectomy [5, 6]. The LG approach provides several advantages, including a magnified view and minimal invasiveness. However, LG is generally avoided for patients with a history of abdominal surgery (HAS) because of the risk of injuring the gut during the exfoliation of adhesions. The treatment protocols for clinical trials that test LG feasibility have typically implemented exclusion criteria that include HAS [3, 7]. Although several studies have evaluated the feasibility of LG for patients with a history of gastrectomy, other upper abdominal open surgery, or minor abdominal surgery [8–12] to our knowledge, no reports have demonstrated the feasibility of LG for patients with HAS, including lower abdominal or hepatobiliary surgery. Therefore, the safety and feasibility of LG for patients with a history of any major abdominal surgery remains controversial. This study assesses the safety and feasibility of LG for patients with gastric cancer and a history of any abdominal surgery.

Methods

Patient selection criteria

This retrospective study was performed without any study-driven clinical interventions. No materials or data were sent to external institutions, to protect the privacy of the patients. This study was conducted with the approval of the ethics committee of Osaka University, Graduate School of Medicine (approved protocol numbers: #08226-6). We reviewed recorded data retrieved from a database that was prospectively dedicated to gastrectomy performed in our institution. We identified 813 patients with gastric cancer or submucosal tumors, such as gastrointestinal stromal tumors, who underwent laparoscopic surgery between January 1997 and October 2015. We defined the indications for LG based on the stage of gastric cancer according to the Japanese Classification of Gastric Carcinoma, and we modified this indication according to changes that occurred in the following periods. Between 1997 and 2000, stage cT0-1N0 was an indication for a distal gastrectomy; from 2001, stage cT0-1N0 was an indication for a total gastrectomy; [6] and from 2010, stages cT0-1N0-1 and cT2N0 were absolute indications for gastrectomy and cT2-4aNany was a relative indication for gastrectomy. Moreover, from 2004, we expanded the indications for LG to include patients with HAS. We identified 44 consecutive patients with a HAS, who underwent attempted gastrectomy for gastric cancer during the study period. Three of the patients underwent open gastrectomy: one, because another open abdominal procedure was required simultaneously; two, because of high-risk coexisting conditions that necessitate completing the resection as quickly as possible. All the other patients ($n=41$) underwent LG. Written informed consent to undergo laparoscopic surgery was obtained from all patients. Gastric cancer was diagnosed based on pathological examination before surgery in all patients, who underwent gastrectomy with lymph node dissection. We analyzed the patient characteristics, surgical outcomes, risk factors for conversion to open surgery and postoperative complications.

Laparoscopic gastrectomy

All operations were performed by or supervised by surgeons with sufficient experience in LG to be certified by the Japan Society for Endoscopic Surgery. The first step in LG was to insert the first port. After the induction of general anesthesia, the patient was placed in a supine position with the legs slightly apart. The first port was typically inserted via the open method at a periumbilical or umbilical site. Although adhesions were often encountered beneath a periumbilical site, it was usually possible to dissect the adhesion under direct visual guidance. When a severe adhesion beneath the periumbilical site was suspected based on findings on preoperative ultrasonic or computed tomography images, the first port was inserted at another site, which had not been touched during the previous surgery. For example, a left upper abdominal site was chosen when the past surgery had involved a right upper abdominal incision. When it did not seem safe to insert the first port, or when it was difficult to acquire surgical exposure because of a peritoneal adhesion, we attempted to insert another port at the site of another untouched area, and when necessary, this procedure was repeated up to three times. After three failed attempts to insert the first port, we converted the LG approach to open gastrectomy.

After the first port was inserted, pneumoperitoneum was created by the insufflation of carbon dioxide to 8–10 mmHg. Once pneumoperitoneum was achieved and another port was inserted, the adhesions could be dissected because the pneumoperitoneum elevates the abdominal wall to provide a better dissection plane with laparoscopy. Thereafter, the adhesions were dissected until all the ports were safely inserted (Fig. 1). After the adhesions were dissected, the surgeons performed LG with lymph node dissection according to the Japanese Gastric Cancer Treatment Guidelines. Patients with cT1 carcinomas underwent D1 or D1 plus dissection; patients with cT2 disease underwent D2 or D2 minus splenic hilum node dissections; in some patients, a partial gastrectomy without lymphadenectomy was performed. Typically, we performed Billroth I reconstruction for patients who underwent laparoscopic distal gastrectomy, and Roux-en-Y reconstruction for patients who underwent laparoscopic total gastrectomy.

Conversion to open surgery

When LG was difficult to complete because of severe peritoneal and intestinal adhesions that restricted surgical exposure or because of abdominal organ injuries, the LG was converted to open surgery. Before performing LG, we considered whether all of the procedures could be performed safely. For example, even when the exfoliation of peritoneal adhesions could be performed safely, it might have been difficult to complete LG if severe adhesion of the jejunum made it impossible to lift the jejunum for Roux-en-Y reconstruction. In those cases, conversion to open surgery was done early to prevent prolonged operation times.

Grading of postoperative complications

Postoperative complications were categorized into six grades according to the Clavien–Dindo (C–D) classification.[13, 14], namely no complications (grade 0); deviation from a normal hospital course, but no need for medication

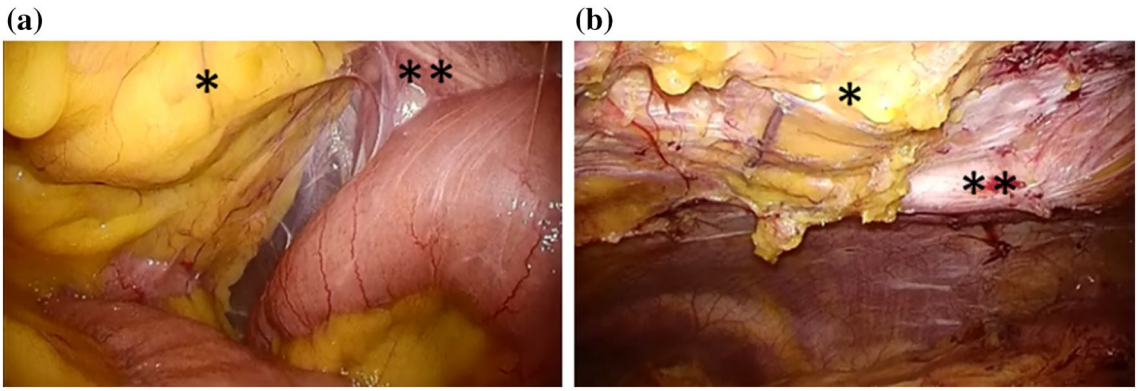

Fig. 1 Laparoscopic view of intra-abdominal adhesions. **a** Adhesion after abdominal surgery; **b** the same regions after exfoliating the intra-abdominal adhesions. *Asterisks* indicate the same areas before and after exfoliation of the peritoneal adhesions

or intervention (grade I); complications requiring drugs or a blood transfusion (grade II); complications requiring intervention (grade III); life-threatening complications necessitating transfer to ICU (grade IV); death (grade V). Complications were recorded during the hospital stay, starting from the day of surgery and ending on the day of discharge. When additional intervention after LG was part of the planned treatment, it was not considered a complication. When one patient suffered multiple complications, the complication with the highest grade was included in the analysis. In this study, grade III or higher complications were defined as severe complications.

Statistics

Statistical analyses were performed with the JMP Pro software program, version 11.0 for Windows (JMP, SAS Institute Inc. North Carolina, USA). Differences among groups were examined for significance using Student's *t* test with Yates' correction, the Chi-squared test, Fisher's exact probability test, or the Mann–Whitney *U* test. *P* values < 0.05 were considered significant.

Results

Patient characteristics and perioperative features

There were 32 men (78.0%) and 9 women (22.0%), with a median age of 71 years. Table 1 summarizes the HAS among the patients. The planned procedures included laparoscopic total gastrectomy in 6 patients, laparoscopic remnant gastrectomy in 13 patients, laparoscopic distal gastrectomy in 18 patients, laparoscopic proximal gastrectomy in 1 patient, and laparoscopic partial gastrectomy in 3 patients. The first port insertions were made at the periumbilical or umbilical site in 29 patients, the left upper abdomen in 5 patients, the left side of the abdomen in 4 patients, and the left lower abdomen, the right upper abdomen, and the right lower abdomen in one patient each. In three patients, the first port had to be reinserted because of a peritoneal adhesion that prevented surgical exposure, and the LG could not be completed in any of these three patients. The median operation time was 255 (115–420) min, and the median intra-operative blood loss was 110 (1–770) ml. All patients underwent curative gastrectomy (R0), and there were no intra-operative

Table 1 Operative history of the patients who underwent laparoscopic gastrectomy for gastric cancer

Previous surgery	$N=41$[a]
Upper gastrointestinal tract surgery	15
Lower gastrointestinal tract surgery	20
Hepato-biliary-pancreatic surgery	9
Surgery for acute peritonitis	10
Surgery for cancer	32
Gastrectomy	14
Colorectal surgery	14
Resection of intestinal tract for peritonitis	6
Appendectomy	4
Hepatectomy	4
Cholecystectomy	4
Gynecological surgery	3
Urological surgery	2
Common bile duct exploration	2
Surgery for abdominal aortic aneurysm	1
Incisional hernia repair	1
Closure of colostomy	1
Number of past abdominal operations 1/2/3/4	33/3/3/2
Interval from previous abdominal surgery, years: median (range)	9.2 (0.6–62.9)
Laparotomy/only laparoscopic surgery	30/11

[a]Eight patients had a history of two or more laparotomies

complications. The median postoperative hospital stay was 16 (9–84) days.

Risk factors for conversion to open surgery

Conversion to open surgery was necessitated by severe adhesion in six patients (14.6%); as peritoneal adhesions in four and adhesions between small bowel sections in two. There was no case of conversion to open surgery for an organ injury. In all cases, the decision to convert to open surgery was made early and based on intra-abdominal observations. We compared the clinicopathological features of patients with vs. those without conversion to open surgery (Table 2). We found that a history of lower gastrointestinal tract surgery ($p=0.009$) and an attempt to perform a laparoscopic total gastrectomy ($p=0.002$) were associated with a higher incidence of conversion to open surgery. Moreover, the patients who required open surgery had significantly higher blood loss ($p\leq0.001$) and postoperative serum CRP levels ($p=0.003$) than those who underwent complete LG.

Risk factors for postoperative complications

The perioperative morbidity and mortality rates were 36.6% ($n=15$) and 2.4% ($n=1$), respectively. The postoperative

Table 2 Clinicopathological features of patients who underwent complete laparoscopic gastrectomy vs. those with conversion to open surgery

	All patients ($N=41$)		
	Complete LG	Conversion to open surgery	*P* value
	$n=35$	$n=6$	
Age, years: median (range)	71 (56–91)	69.5 (61–78)	0.598
Gender male/female	28/7	4/2	0.597
Body mass index, kg/m^2: median (range)	21.0 (16.4–28.7)	23.8 (21.0–24.8)	0.187
ASA-PS 1/2/3	12/20/3	2/4/0	0.598
Location of tumor U/M/L	13/12/10	3/2/1	0.775
cT stage 1/2/3/4	28/4/2/1	5/0/1/0	0.523
cN stage 0/1/2	32/2/1	6/0/0	0.610
Previous abdominal surgery (%)			
Upper gastrointestinal tract surgery			
+	15 (100)	0 (0)	0.070
−	20 (76.9)	6 (23.1)	
Lower gastrointestinal tract surgery			
+	14 (70.0)	6 (30.0)	0.009
−	21 (100)	0 (0)	
Hepato-biliary-pancreatic surgery			
+	6 (66.7)	3 (33.3)	0.108
−	29 (90.6)	3 (9.4)	
Surgery for acute peritonitis			
+	7 (70.0)	3 (30.0)	0.144
−	28 (90.3)	3 (9.7)	
Surgery for cancer	27 (84.4)	5 (15.6)	1.000
benign disease	8 (88.9)	1 (11.1)	
Laparotomy	24 (80.0)	6 (20.0)	0.167
Only laparoscopic surgery	11 (100)	0 (0)	
Time interval from first abdominal surgery years: median (range)	9.0 (0.6–62.9)	13.7 (3.5–38.4)	0.302
Planned operation LTG/other	2/33	4/2	0.002
Lymph node dissection D0-1+/2	30/5	4/2	0.268
Operation time, minutes: median (range)	250 (115–397)	263 (185–420)	0.507
Blood loss, g: median (range)	100 (1–770)	440 (400–550)	<0.001
Highest value of postoperative serum CRP mg/dl: median (range)	7.3 (1.8–39.5)	16.8 (11.3–31.2)	0.003
Highest value of postoperative WBC: median (range)	10,200 (6800–20,250)	10,455 (9450–19,319)	0.356

LG laparoscopic gastrectomy, *ASA-PS* ASA physical status, *WBC* white blood cell, *LTG* laparoscopic total gastrectomy, *CRP* C-reactive protein

complications, graded according to the C–D classification, were distributed as follows: grade 0 in 26 (63.4%) patients, grade I in 2 (4.8%), grade II in 7 (17.1%), grade III in 5 (12.2%), and grade V (in-hospital mortality) in 1 (2.4%). Table 3 lists all the complications. The incidence of severe complications was 14.6% ($n=6$), and the most common complication was anastomotic leakage ($n=3$; 7.3%), followed by intra-abdominal abscess, anastomotic ulcer, and adhesive intestinal obstruction ($n=1$ each; 2.4%). The patient who died after surgery had a history of four previous abdominal operations and the planned operation was laparoscopic total gastrectomy. In this case, the surgeon decided intra-operatively to convert to open gastrectomy to acquire surgical exposure; however, the patient died of multiple organ failure secondary to anastomotic leakage 2.8 months after surgery. We also evaluated the relationships between severe complications and clinicopathological parameters (Table 4). The type of past abdominal surgery was not significantly correlated with the occurrence of severe complications. Although it was not significant, there was a higher incidence of severe postoperative complications (two of six patients) among those who underwent attempted laparoscopic total gastrectomy. A similar result was observed among patients who required conversions to open surgery. Other intra-operative factors were not associated with the incidence of severe postoperative complications, including the grade of lymph node dissection, the operation time, or the amount of blood loss. Only the postoperative CRP value was significantly correlated with severe complications ($p=0.039$).

Discussion

LG is an established, standard surgical treatment option for early gastric cancer, particularly in Japan and Korea [3, 15–17]. The advantages of LG over open surgery include a shorter hospital stay, less intra-operative bleeding and postoperative pain, and improved peristalsis after surgery [18, 19]. LG could also have advantages over open surgery for patients with a HAS. Previous retrospective studies have found no difference in short-term outcomes following laparoscopy-assisted gastrectomy or laparoscopy-assisted remnant gastrectomy, between patients with and those without a HAS [8–12, 20–25]. However, almost all of the patients in those studies had undergone only minor surgery in the abdomen or only the upper abdomen. To our knowledge, this is the first study to demonstrate the safety and feasibility of LG in patients with all types of past abdominal surgery.

Previous studies have found rates of conversion to open surgery of 4.0-6.25% for patients undergoing LG after past upper abdominal surgery or minor abdominal surgery [8, 9, 12]. The conversion rate in present series was higher. In the previous studies, there were five cases of conversion to open surgery, and for four of these, the conversion was for oncological reasons such as further lymph node dissection. On the other hand, all six cases of conversion in the present study were necessitated by adhesions caused by their past abdominal surgery. This discrepancy could be caused by differences in the types of past surgery. Indeed, all six patients in this study had a history of open lower gastrointestinal tract surgery, and five patients underwent surgery for colorectal cancer. Tokunaga et al. [9] also reported two cases of conversion to open surgery among 32 patients with a history of upper abdominal surgery who underwent LG. One of these conversions involved a patient with a history of right colectomy with D3 lymph node dissection for colic cancer. In our series, severe abdominal adhesions were common in both the lower and upper abdomen after previous lower abdominal surgery; in contrast, lower abdominal adhesions were less common than upper abdominal adhesions after a previous upper abdominal surgery. This implies that lower gastrointestinal tract surgery can cause adhesions over the entire abdominal wall, making it physically impossible to insert the first port or to achieve sufficient surgical exposure for gastrectomy. We think that this explains the association between a history of lower gastrointestinal tract surgery and a higher incidence of conversion to open surgery.

We found that attempted total gastrectomy was also correlated with conversion to open surgery. This conflicts with the findings of previous reports, but it is surgically plausible. It was difficult to exfoliate ball-shaped jejuno-to-jejuno adhesions laparoscopically than via open surgery. In almost all cases of ball-shaped jejuno-to-jejuno adhesions, lifting the jejunum, which was required for Roux-en-Y reconstruction, could not be performed laparoscopically. For this reason, patients who underwent attempted laparoscopic total gastrectomy might have been at a higher risk for conversion to open surgery than those who underwent other types

Table 3 Postoperative complications after laparoscopic gastrectomy

Complication	C–D classification I/II/III/V
Anastomotic leakage	0/1/2/1
Anastomotic hemorrhage	0/3/0/0
Adhesive intestinal obstruction	1/0/1/0
Wound infection	1/1/0/0
Intra-abdominal abscess	0/1/1/0
Anastomotic ulcer	0/0/1/0
Intra-abdominal bleeding	0/1/0/0

C–D classification Clavien–Dindo classification

Table 4 Comparison of clinicopathological features in patients with serious vs. those with non-serious complications after laparoscopic gastrectomy

	All Patients (N = 41)		
	Non-serious complication (<Grade III) $n = 35$	Serious complication (≥Grade III) $n = 6$	*P* value
Age, years: median (range)	73 (56–91)	68.5 (65–84)	0.968
Gender male/female	28/7	4/2	0.597
Body mass index, kg/m2: median (range)	21.2 (16.4–28.7)	22.5 (21.0-27.4)	0.365
ASA-PS 1/2/3	13/20/2	1/4/1	0.476
Location of tumor U/M/L	13/13/9	3/1/2	0.589
cT stage 1/2/3/4	27/4/3/1	6/0/0/0	0.416
cN stage 0/1/2	32/2/1	6/0/0	0.610
Previous abdominal surgery (%)			
Upper gastrointestinal tract surgery			
+	13 (86.7)	2 (13.3)	1.000
−	22 (84.6)	4 (15.4)	
Lower gastrointestinal tract surgery			
+	17 (85.0)	3 (15.0)	1.000
−	18 (85.7)	3 (14.3)	
Hepato-biliary-pancreatic surgery			
+	8 (88.9)	1 (11.1)	1.000
−	27 (84.4)	5 (15.6)	
Surgery for acute peritonitis			
+	9 (90.0)	1 (10.0)	1.000
−	26 (83.9)	5 (16.1)	
Surgery for cancer	26 (81.3)	6 (18.7)	0.309
benign disease	9 (100)	0 (0)	
Laparotomy	27 (90.0)	3 (10.0)	0.316
Only laparoscopic surgery	8 (72.7)	3 (27.3)	
Time interval from first abdominal surgery years: median(range)	9.3 (0.6–32.9)	5.7 (1.5–38.4)	0.417
Planned operation LTG/other	4/31	2/4	0.206
Conversion to open surgery +/–	4/31	2/4	0.206
Lymph node dissection D0-1+/2	29/6	5/1	1.000
Operation time, minutes: median (range)	255 (115–417)	250.5 (195–420)	0.658
Blood loss, g: median (range)	100 (1–770)	140 (80–550)	0.276
Highest value of postoperative serum CRP mg/dl: median (range)	7.4 (1.8–25.7)	14.7 (5.5–39.5)	0.039
Highest value of postoperative WBC: median (range)	9880 (6800–20,250)	11,985 (7720–19,319)	0.268

LG laparoscopic gastrectomy, *ASA-PS* ASA physical status, *WBC* white blood cell, *LTG* laparoscopic total gastrectomy, *CRP* C-reactive protein

of LG. Moreover, the interval between the first abdominal surgery and the attempted LG surgery tended to be shorter in patients who underwent complete LG than in those who required conversion to open surgery, although the difference was not significant. This suggests that recent intra- and postoperative management approaches, such as the use of a sodium hyaluronate carboxymethylcellulose bioresorbable membrane and early postoperative ambulation, might reduce the formation of postoperative intra-abdominal adhesions.

Previous reports showed that, despite a longer operation time, LG had some advantages over open gastrectomy for patients with a HAS in terms of low intra-operative blood loss and early oral intake after surgery [10–12]. Although no direct comparative data between LG and open gastrectomy were presented in this study, we believe that smaller incisions and more accurate dissection of abdominal wall adhesions using pneumoperitoneum and magnified views can minimize the risk of abdominal wall "re-adhesions" after gastrectomy compared with open surgery, which is an additional advantage of LG. On the other hand, open gastrectomy seemed to be more suitable for the dissection of intestinal adhesions, especially ball-shaped jejuno-to-jejuno adhesions.

Although the laparoscopic approach has multiple benefits, it posed technical difficulties in patients with HAS and complications must be considered. In a recent study, the rate of severe postoperative complications in patients without a HAS who underwent LG with D2 lymph node dissections for advanced gastric cancer was 5.8% [5]. On the other hand, in previous studies of gastric cancer patients with HAS, severe postoperative complications occurred at rates of 10.0-15.6% after LG [8, 9, 12]. In the present study, the rate of severe complications was 14.6% after LG for gastric cancer in patients with HAS. Although this was acceptable compared with rates previously reported for LG for gastric cancer in patients with HAS, it was higher than the rate reported for patients without HAS, and this needs to be improved. Our experience included a relatively long learning curve for this procedure. In fact, the rate of severe complications was 23.8% (5/21 cases) until 2 years ago, but that decreased to 5.0% (1/20 cases) in the final 2 years. It is considered that sufficient experience is needed to perform LG in patients with HAS as safely as in patients without HAS.

We also demonstrated that attempted laparoscopic total gastrectomy and conversion to open surgery were associated with a higher incidence of severe postoperative complications. Although this did not reach significance, it may be important from a clinical perspective. As mentioned, laparoscopic total gastrectomy for patients with HAS was considered to be difficult because intestinal adhesions had to be separated to enable lifting the jejunum for a Roux-en-Y reconstruction. Thus, the severe complication rate was relatively higher after laparoscopic total gastrectomy than after other types of LG. This finding suggested first that the indications for LG should be considered carefully for patients scheduled to undergo total gastrectomy; second, it is important to evaluate jejuno-to-jejuno adhesions and decide whether conversion to open gastrectomy is needed at the start of surgery for those with HAS. If lifting the jejunum is difficult because of adhesions, the need for conversion to open surgery should be decided as early as possible.

We acknowledge that this study had several limitations. First, it was designed as a single-institutional, non-controlled, retrospective study on a small number of patients. Second, as we attempted LG in almost all patients during the study period, we could not compare LG with open gastrectomy for patients with HAS. Finally, the duration of follow-up after surgery was relatively short, so the influence on the prognosis is unclear. A study on a larger cohort with assessment of several prognostic factors [26] and longer follow-up is required to validate the clinical significance of our findings.

In conclusion, conversion to open surgery in this series was associated with a history of lower gastrointestinal tract surgery, attempted laparoscopic total gastrectomy, and excessive blood loss. However, we found that LG for gastric cancer was feasible in patients with a history of any type of abdominal surgery, although if the previous surgery was in the lower gastrointestinal tract or if patients with HAS require a total gastrectomy, surgeons should consider the indications for LG carefully.

Compliance with ethical standards

Conflict of interest We have no conflicts of interest to declare.

References

1. Kitano S, Iso Y, Moriyama M, Sugimachi K. Laparoscopy-assisted Billroth I gastrectomy. Surg Laparosc Endosc. 1994;4:146–8.
2. Yamashita K, Sakuramoto S, Kikuchi S, Futawatari N, Katada N, Hosoda K, et al. Laparoscopic versus open distal gastrectomy for early gastric cancer in Japan: long-term clinical outcomes of a randomized clinical trial. Surg Today. 2016;46:741–9.
3. Katai H, Sasako M, Fukuda H, Nakamura K, Hiki N, Saka M, et al. Safety and feasibility of laparoscopy-assisted distal gastrectomy with suprapancreatic nodal dissection for clinical stage I gastric cancer: a multicenter phase II trial (JCOG 0703). Gastric Cancer. 2010;13:238–44.
4. Japanease Gastric Cancer Association. Japanese gastric cancer treatment guidelines 2014 (ver. 4). Gastric Cancer. 2016.
5. Inaki N, Etoh T, Ohyama T, Uchiyama K, Katada N, Koeda K, et al. A Multi-institutional, Prospective, Phase II Feasibility Study of Laparoscopy-Assisted Distal Gastrectomy with D2 Lymph Node Dissection for Locally Advanced Gastric Cancer (JLSSG0901). World J Surg. 2015.
6. Wada N, Kurokawa Y, Takiguchi S, Takahashi T, Yamasaki M, Miyata H, et al. Feasibility of laparoscopy-assisted total gastrectomy in patients with clinical stage I gastric cancer. Gastric Cancer. 2014;17:137–40.
7. Nakamura K, Katai H, Mizusawa J, Yoshikawa T, Ando M, Terashima M, et al. A phase III study of laparoscopy-assisted versus open distal gastrectomy with nodal dissection for clinical stage IA/IB gastric Cancer (JCOG0912). Jpn J Clin Oncol. 2013;43:324–7.
8. Nunobe S, Hiki N, Fukunaga T, Tokunaga M, Ohyama S, Seto Y, et al. Previous laparotomy is not a contraindication to laparoscopy-assisted gastrectomy for early gastric cancer. World J Surg. 2008;32:1466–72.
9. Tokunaga M, Hiki N, Fukunaga T, Nunobe S, Ohyama S, Yamaguchi T. Laparoscopy-assisted gastrectomy for patients with earlier upper abdominal open surgery. Surg Laparosc Endosc Percutan Tech. 2010;20:16–9.
10. Nagai E, Nakata K, Ohuchida K, Miyasaka Y, Shimizu S, Tanaka M. Laparoscopic total gastrectomy for remnant gastric cancer: feasibility study. Surg Endosc. 2014;28:289–96.
11. Kwon IG, Cho I, Guner A, Choi YY, Shin HB, Kim HI, et al. Minimally invasive surgery for remnant gastric cancer: a comparison with open surgery. Surg Endosc. 2014;28:2452–8.
12. Tsunoda S, Okabe H, Obama K, Tanaka E, Akagami M, Kinjo Y, et al. Laparoscopic gastrectomy for patients with a history of upper abdominal surgery: results of a matched-pair analysis. Surg Today. 2014;44:271–6.
13. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a

cohort of 6336 patients and results of a survey. Ann Surg. 2004;240:205–13.
14. Katayama H, Kurokawa Y, Nakamura K, Ito H, Kanemitsu Y, Masuda N, et al. Extended Clavien-Dindo classification of surgical complications: Japan Clinical Oncology Group postoperative complications criteria. Surg Today. 2015.
15. Adachi Y, Shiraishi N, Shiromizu A, Bandoh T, Aramaki M, Kitano S. Laparoscopy-assisted Billroth I gastrectomy compared with conventional open gastrectomy. Arch Surg. 2000;135:806–10.
16. Shimizu S, Uchiyama A, Mizumoto K, Morisaki T, Nakamura K, Shimura H, et al. Laparoscopically assisted distal gastrectomy for early gastric cancer: is it superior to open surgery? Surg Endosc. 2000;14:27–31.
17. Lee SI, Choi YS, Park DJ, Kim HH, Yang HK, Kim MC. Comparative study of laparoscopy-assisted distal gastrectomy and open distal gastrectomy. J Am Coll Surg. 2006;202:874–80.
18. Kitano S, Shiraishi N, Uyama I, Sugihara K, Tanigawa N. A multicenter study on oncologic outcome of laparoscopic gastrectomy for early cancer in Japan. Ann Surg. 2007;245:68–72.
19. Zeng YK, Yang ZL, Peng JS, Lin HS, Cai L. Laparoscopy-assisted versus open distal gastrectomy for early gastric cancer: evidence from randomized and nonrandomized clinical trials. Ann Surg. 2012;256:39–52.
20. Yamada H, Kojima K, Yamashita T, Kawano T, Sugihara K, Nihei Z. Laparoscopy-assisted resection of gastric remnant cancer. Surg Laparosc Endosc Percutan Tech. 2005;15:226–9.
21. Corcione F, Pirozzi F, Marzano E, Cuccurullo D, Settembre A, Miranda L. Laparoscopic approach to gastric remnant-stump: our initial successful experience on 3 cases. Surg Laparosc Endosc Percutan Tech. 2008;18:502–5.
22. Song J, Kim JY, Kim S, Choi WH, Cheong JH, Hyung WJ, et al. Laparoscopic completion total gastrectomy in remnant gastric cancer: technical detail and experience of two cases. Hepatogastroenterology. 2009;56:1249–52.
23. Qian F, Yu PW, Hao YX, Sun G, Tang B, Shi Y, et al. Laparoscopy-assisted resection for gastric stump cancer and gastric stump recurrent cancer: a report of 15 cases. Surg Endosc. 2010;24:3205–9.
24. Shinohara T, Hanyu N, Tanaka Y, Murakami K, Watanabe A, Yanaga K. Totally laparoscopic complete resection of the remnant stomach for gastric cancer. Langenbecks Arch Surg. 2013;398:341–5.
25. Son SY, Lee CM, Jung DH, Lee JH, Ahn SH, Park do J, et al. Laparoscopic completion total gastrectomy for remnant gastric cancer: a single-institution experience. Gastric Cancer. 2015;18:177–82.
26. Wada N, Kurokawa Y, Miyazaki Y, Makino T, Takahashi T, Yamasaki M, et al. The characteristics of the serum carcinoembryonic antigen and carbohydrate antigen 19–9 levels in gastric cancer cases. Surg Today. 2017;47:227–32.