15-year experience of laparoscopic gastrectomy in advanced gastric cancer: analysis on short-term and long-term oncologic outcome

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Abstract

Background Laparoscopic gastrectomy (LG) is now a widely accepted treatment option for gastric cancer. However, there is insufficient evidence for LG for advanced gastric cancer (AGC). Many retrospective studies have shown that LG for AGC is safe and feasible, but very few studies have shown the actual outcome in general practice. The aim of this study is to analyze our last 15 years of experience in LG for AGC.

Methods This is a retrospective review from May 2003 to May 2017 in Seoul National University Bundang Hospital. A total of 1592 patients who had LG for AGC were enrolled of which 109 patients with open conversion were excluded. We evaluated the short-term and long-term oncologic outcomes of LG for AGC.

Results A total of 1483 patients were analyzed. There were 432 cases of total gastrectomy, 982 cases of distal gastrectomy, and 69 cases of proximal gastrectomy. The total complication rate was 9.1% (135/1483), which included wound-related complications (0.7%), postoperative bleeding (0.5%), anastomosis or stump leakage (2.2%), intestinal obstruction (0.9%), pancreatic fistula (0.1%), intra-abdominal abscess (1.6%), and lung morbidity (3.0%). The rate of Clavien-Dindo grade 3 and above complications was 4.9%. Age was the only significant risk factor in multivariate analysis (OR 1.02; 95% CI, 1.01–1.04, $P = 0.01$). 5-year overall survival stratified by stage was as follows: stage IB 88.9%, stage IIA 88.7%, stage IIB 84.2%, stage IIIA 71.7%, stage IIIB 56.8%, stage IIIC 45.4%, and stage IV 25%. Total recurrence rate was 14.4%, which included local recurrence (1.1%) and distant metastases (13.3%).

Conclusions During our 15 years of experience, we have successfully performed 1483 cases of AGC with laparoscopy. Our results showed short-term and long-term oncologic outcomes that were comparable with other studies. LG is safe and feasible in general practice for advanced gastric cancer when performed by experienced surgeons.

Keywords Laparoscopy · Advanced gastric cancer · Gastrectomy · Morbidity · Survival

Laparoscopic gastrectomy (LG) is now a widely accepted treatment option for gastric cancer since its introduction by Kitano et al., especially for early gastric cancer (EGC). [1] The Japanese JCOG 0912 study reported similar complication rates after laparoscopic and open distal gastrectomy (DG) for EGC, while the Korean KLASS-01 study showed that laparoscopic DG was associated with lower incidence of overall postoperative complications [2, 3]. KLASS-01 study also proved non-inferiority of laparoscopy over open DG in long-term survival. [4] There are many retrospective studies that show that LG for advanced gastric cancer (AGC) is safe and feasible when compared with open gastrectomy (OG) [5–7]. However, most of these studies are limited by their small sample size. In 2008, we initiated the first prospective single arm phase 2 trial of LG for AGC [8]. We showed acceptable morbidity and mortality rate, demonstrating the safety and technical feasibility of laparoscopy for AGC. The recent Chinese CLASS-01 trial showed similar 3-year survival between laparoscopy and open. [9] The long-term results of KLASS-02 and JLSSG0901 are pending [10].

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Well-controlled clinical studies are important for building evidence for laparoscopy. However, they do not reflect the actual outcome of laparoscopy for AGC in real-life practice. Therefore, we aim to analyze all AGC patients who received laparoscopic gastrectomy for the last 15 years since the opening of our institution. The endpoints studied are postoperative morbidity and long-term oncologic outcome. To our knowledge, this is the largest study to show real-life long-term outcome in general practice.

Materials and methods

Patient population

This is a retrospective review of electronic medical records from May 2003 to May 2017 in Seoul National University Bundang Hospital. A total of 1592 patients underwent LG for AGC during this 15-year time period. All patients were included in this analysis, except for 109 patients who had open conversion from laparoscopy. From 2003 to 2008, patients with serosa-exposed tumors underwent open gastrectomy. A total of 1483 patients who successfully underwent LG were analyzed. Patient consent for the use of retrospective hospital data was not necessary for this study (IRB Approval No B-1908/558-101).

Surgical techniques in laparoscopic gastrectomy for AGC

After initiation of our prospective phase II clinical trial, we gradually extended our indications for LG, with resultant increase in case numbers. Endoscopic ultrasonography for AGC was not routinely performed. CT (Computed Tomography) was performed for preoperative staging. Lymph node dissection (LND) was done for tumors from cT2 to cT4a according to the Korean and Japanese guidelines. [11, 12] D2 dissection was not possible in some cases due to patient factors, and a minimal LND (D1) was performed instead. D2 + LND is defined as the excision of additional LNs outside the D2 area, including paraaortic LNs. For DG, we performed Billroth-I, Billroth-II with or without Braun jejunojejunostomy, Roux-Y gastrojejunostomy, and uncut Roux-Y gastrojejunostomy. For all total gastrectomies (TG), Roux-Y esophagojejunostomy and jejunojejunostomy was performed. The first laparoscopic proximal gastrectomy (PG) was performed in 2004, and up to 2009, 7 patients with AGC had undergone PG with Esophago-gastrostomy (E–G stomy). After 2009, we started performing Double-Tract-Reconstruction (DTR) technique because of its lower incidence of late complications such as gastroesophageal reflux and anastomotic stenosis [13]. The anastomosis technique for each gastrectomy type was not analyzed in this study.

Definition of recurrence

Tumors can recur near the previous operative field or away, which sometimes presents as distant metastasis. We defined local recurrence as recurrence occurring at the remnant stomach (either synchronous or metachronous), anastomosis site, or regional LNs. Distant metastasis included peritoneal, solid organ, and para-aortic LN metastasis. Peritoneal metastasis was diagnosed with CT or diagnostic laparoscopy and solid organ metastasis was determined with CT, MRI, or PET/CT imaging.

Survival analysis

All Korean citizens have mandatory national health insurance where all medical cost spent and survival status is reported to the government. Therefore, survival data was obtained from the National Statistics Service of Korea, allowing us to accurately calculate the survival rate.

Statistical analysis

Continuous values are expressed as the mean and standard deviation. To identify the risk factors for postoperative morbidity, univariate and multivariate analyses were performed using Chi- square tests and binary logistic regression models. Survival analysis was done with Kaplan–Meier method, and survival probabilities were compared using log-rank test. Data were analyzed using SPSS statistics software, version 20 (IBM Inc, Armonk, NY, USA) and software R (Version 3.3.2, R Foundation for Statistical Computing, Vienna, Austria). A P value ≤ 0.05 was considered to be statistically significant for all analyses.

Results

Clinicopathologic characteristics according to gastrectomy types

Table 1 shows the patient demographics of all the patients according to gastrectomy types. DG was the most common type of surgery (66.2%) followed by TG (29.1%) and PG (4.7%). TG had the longest operation time and the most estimated blood loss (EBL). There were no D2 or D2 + LND in PG due to the absence of D2 LND by definition [12]. 17 cases of D1 LND were performed for palliative gastrectomy cases. The mean number of LNs retrieved was about 61.4 ± 24.8. The most common histologic types were tubular adenocarcinoma moderately differentiated, followed by poorly differentiated, and then poorly cohesive carcinoma.

Table 1 Patient demographics

	Total gastrectomy (N=432)	Distal gastrectomy (N=982)	Proximal gastrectomy (N=69)	Total (N=1483)
Sex				
Male	284 (65.8%)	640 (65.2%)	49 (71.0%)	973 (65.6%)
Female	148 (34.2%)	342 (34.8%)	20 (29.0%)	510 (34.4%)
Age	60.1 ± 13.2	61.9 ± 13.5	61.7 ± 13.5	61.3 ± 13.5
Body mass index	23.2 ± 3.4	23.4 ± 3.2	24.3 ± 3.6	23.4 ± 3.3
ASA score[a]				
1	182 (42.0%)	368 (37.5%)	24 (34.8%)	574 (38.7%)
2	221 (51.0%)	546 (55.6%)	40 (58.0%)	807 (54.4%)
3	30 (6.9%)	66 (6.7%)	4 (5.8%)	100 (6.7%)
4	0 (0%)	2 (0.2%)	1 (1.4%)	3 (0.2%)
Previous operations	88 (20.3%)	150 (15.3%)	9 (13.0%)	247 (16.7%)
Operation time (min)	251.6 ± 69.8	190.1 ± 62.4	220.5 ± 77.1	209.4 ± 71.1
Estimated blood loss (mL)	141.9 ± 171.5	82.0 ± 97.2	64.8 ± 92.4	99.0 ± 126.6
Lymph node dissection				
D1	6 (1.4%)	9 (0.9%)	2 (2.9%)	17 (1.1%)
D1+	86 (19.9%)	270 (27.5%)	67 (97.1%)	423 (28.5%)
D2	335 (77.5%)	695 (70.8%)	0 (0%)	1030 (69.5%)
D2+	5 (1.2%)	8 (0.8%)	0 (0%)	13 (0.9%)
Retrieved lymph nodes	70.1 ± 28.9	58.7 ± 22.1	43.0 ± 17.8	61.4 ± 24.8
Histologic type				
Papillary AC[*]	1 (0.2%)	3 (0.3%)	0 (0%)	4 (0.3%)
Tubular AC[*], WD[†]	4 (0.9%)	42 (4.3%)	5 (7.3%)	51 (3.4%)
Tubular AC[*], MD[‡]	102 (23.6%)	349 (35.5%)	27 (39.1%)	478 (32.2%)
Tubular AC[*], PD[✳]	138 (31.9%)	258 (26.3%)	11 (15.9%)	407 (27.4%)
Mucinous AC[*]	4 (0.9%)	22 (2.2%)	1 (1.5%)	27 (1.8%)
Poorly cohesive ca.	129 (29.9%)	200 (20.4%)	16 (23.2%)	345 (23.3%)
Others	54 (12.5%)	108 (11.0%)	9 (13.0%)	171 (11.5%)
Tumor size (cm)	7.1 ± 3.7	4.6 ± 2.2	3.6 ± 1.7	5.3 ± 3.0
T stage				
T2	74 (17.1%)	430 (43.8%)	48 (68.3%)	552 (37.2%)
T3	169 (39.1%)	333 (33.9%)	12 (17.5%)	514 (34.7%)
T4a	169 (39.1%)	197 (20.1%)	9 (14.3%)	375 (25.3%)
T4b	20 (4.6%)	22 (2.2%)	0 (0%)	42 (2.8%)
N stage				
N0	96 (22.2%)	365 (37.2%)	36 (52.2%)	497 (33.5%)
N1	59 (13.7%)	191 (19.5%)	20 (29.0%)	270 (18.2%)
N2	82 (19.0%)	174 (17.7%)	6 (8.7%)	262 (17.7%)
N3a	88 (20.3%)	146 (14.9%)	6 (8.7%)	240 (16.2%)
N3b	107 (24.8%)	106 (10.8%)	1 (1.4%)	214 (14.4%)
TNM stage				
IB	238 (24.2%)	37 (8.6%)	30 (43.5%)	305 (20.6%)
IIA	188 (19.1%)	59 (13.7%)	19 (27.5%)	266 (17.9%)
IIB	160 (16.2%)	43 (10.0%)	9 (13.0%)	212 (14.3%)
IIIA	162 (16.5%)	96 (22.2%)	5 (7.2%)	263 (17.7%)
IIIB	118 (12.0%)	77 (17.8%)	4 (5.8%)	199 (13.4%)
IIIC	89 (9.1%)	86 (19.9%)	0 (0%)	175 (11.8%)
IV	27 (2.7%)	34 (7.9%)	2 (3.0%)	63 (4.2%)

[a] American Society of Anesthesiologists

[*] Adenocarcinoma

[†] Well differentiated

[‡] Moderately differentiated

[✳] Poorly differentiated

11.5% were classified as others, which contained mixed and neuroendocrine components. The mean tumor size was the largest in TG (7.1 ± 3.7 cm). All the stages were updated according to AJCC (8th edition). T and N stages are shown in the table. The most common T and N stage was T2 and N0 in total, but for TG, T3, T4a, and N3b were most common. According to our TNM stage data, IB (T2N0) was the most common (20.6%), and then IIA (17.9%), IIIA (17.7%), IIB (14.3%), IIIB (13.4%), IIIC (11.8%), and stage IV (4.2%).

Postoperative morbidity

Postoperative morbidity was defined as complications that occurred within 30 days of surgery. All complications were graded with the Clavien–Dindo (CD) scale [14]. The total complication rate was 9.1% (135/1483) (Table 2). The complications included wound complications (8%), postoperative bleeding (5.2%), anastomosis or stump leakage (23.7%), intestinal obstruction (10.4%), severe pancreatic fistula (0.7%), intra-abdominal abscess (17%), and lung morbidity (32.6%). Also, there was one case of remnant gastric infarction and two cases of colitis. 54% (73 cases) of all complications which were CD grade 3 and above were classified as severe. Four cases of wound complications needed repair with either local or general anesthesia, six postoperative bleeding patients had surgical exploration, and one patient died due to complications after bleeding. Radiologic intervention was done in 27 patients with anastomosis and duodenal stump leakage and in 21 patients with intra-abdominal abscess. Six patients underwent percutaneous drainage for pleural effusion, and one case of remnant gastric infarction received re-operation and conversion to total gastrectomy.

In the univariate analysis, age, ASA score, operation time, estimated blood loss, and total gastrectomy showed statistical significance as risk factors of postoperative morbidity (Table 3). However, on the multivariate analysis, age was the only risk factor with significant value (1.02, 95% CI 1.01–1.04) ($P = 0.01$).

Table 2 Postoperative complication after laparoscopic gastrectomy

Postoperative complications	$N = 1483$
Total	135 (9.1%)
Wound	11 (0.7%)
Bleeding	7 (0.5%)
Leakage	32 (2.2%)
Intestinal obstruction	14 (0.9%)
Severe pancreatic fistula	1 (0.1%)
Intra-abdominal abscess	23 (1.6%)
Lung morbidity	44 (2.9%)
Other complications	3 (0.2%)
Clavien–Dindo grade ≥ 3	73 (4.9%)
Mortality	1 (0.07%)

Table 3 Univariate and multivariate analysis on risk factors of postoperative complication

Variables	Univariate		Multivariate	
	OR (95% CI)	p	OR (95% CI)	p
Sex				
Female	1		1	
Male	1.44 (0.98–2.14)	0.068		
Age	1.03 (1.01–1.04)	< 0.001	1.02 (1.01–1.04)	0.010
Body mass index	1.01 (0.96–1.07)	0.668		
ASA				
1	1		1	
2	1.80 (1.22–2.71)	0.004	1.37 (0.88–2.18)	0.167
3	1.98 (0.96–3.84)	0.052		
4	7.26 (0.33–77.46)	0.109		
Operation time	1.00 (1.00–1.01)	< 0.001		
Estimated blood loss	1.00 (1.00–1.00)	< 0.001		
Type of operation				
Distal	1		1	
Total	1.80 (1.24–2.59)	0.002	1.48 (0.76–2.89)	0.066
Proximal	1.76 (0.75–3.63)	0.155		
Lymph node dissection				
D1	1			
D1+	0.78 (0.66–1.09)	0.376		
D2	0.81 (0.56–1.18)	0.258		
D2+	0.76 (0.04–4.02)	0.791		
Tumor size	1.03 (0.97–1.09)	0.278		
Stage				
IB	1		1	
IIA	1.55 (0.85–2.84)	0.154		
IIB	1.45 (0.76–2.78)	0.260		
IIIA	1.78 (0.95–3.39)	0.074		
IIIB	1.57 (0.82–3.01)	0.173		
IIIC	1.84 (0.97–3.49)	0.061		
IV	1.48 (0.56–3.49)	0.396		

Table 4 5-year overall survival and disease-free-survival according to stage

Stage	5-year overall survival		5-year disease-free survival	
	N	Survival rate	N	Survival rate
Stage IB	305 (20.6%)	88.9%	282 (22.2%)	85.4%
Stage IIA	266 (17.9%)	88.7%	238 (18.7%)	87.2%
Stage IIB	212 (14.3%)	84.2%	194 (15.3%)	78.1%
Stage IIIA	263 (17.7%)	71.7%	232 (18.3%)	65.6%
Stage IIIB	199 (13.4%)	56.8%	174 (13.7%)	50.8%
Stage IIIC	175 (11.8%)	45.4%	148 (11.7%)	25.2%
Stage IV	63 (4.2%)	25.0%		

Survival analysis

Table 4 shows the 5-year overall survival (OS) rate and Fig. 1 shows the Kaplan–Meier curve. Median follow-up was 35.1 months. 5-year OS was 88.9% for stage Ib, 88.7% for stage IIA, 84.2% for stage IIB, 60.3% for stage III (71.7% for stage IIIA, 56.8% for stage IIIB, 45.4% for stage IIIC), and 25% for stage IV.

Excluding 213 patients with other malignancy and palliative gastrectomy, including stage 4 cancer, we analyzed the disease-free survival (DFS) of the remaining 1270 patients (Table 4). 5-year DFS was 85.4% for stage IB, 87.2% for stage IIA, 78.1% for stage IIB, 65.6% for stage IIIA, 50.8% for stage IIIB, and 25.2% for stage IIIC.

Stage 4 gastric cancer

Survival data on stage 4 cancer were analyzed (Table 5). There are no reports on survival analysis of LG for

Table 5 Different types of stage 4 cases

Stage 4 type	63/1483 (4.2%)
Peritoneal seeding	37 (2.5%)
Malignant peritoneal cytology	13 (0.9%)
Distant organ metastasis	4 (0.3%)
Distant LN metastasis	12 (0.8%)

stage 4 AGC cases in the literature. Among our cases, 37 cases (58.7%) had intraoperative peritoneal seeding and 13 cases (20.6%) showed postoperative malignant peritoneal cytology. Four patients had distant organ metastasis involving the liver, ovary, or appendix, which were resected together during the surgery. Some patients had paraaortic LN ($N = 7$) and station 14v metastasis ($N = 5$).

Recurrence analysis

Cancer-specific local recurrence and distant metastasis after the initial LG were analyzed (Table 6). Total recurrence rate was 14.4% (214/1483). There were 16 cases (1.1%) of local recurrence: remnant stomach (5 cases), anastomosis site (3 cases), and regional LN recurrence (8 cases). There were 198 cases (13.3%) of distant metastasis after surgery: peritoneum (78 cases), liver (35 cases), bone (14 cases), lung (6 cases), colon (12 cases), ovary (13 cases), paraaortic LN (32 cases), and other organs (small bowel, bladder, spleen, pleura, gallbladder, skin, and brain, 8 cases).
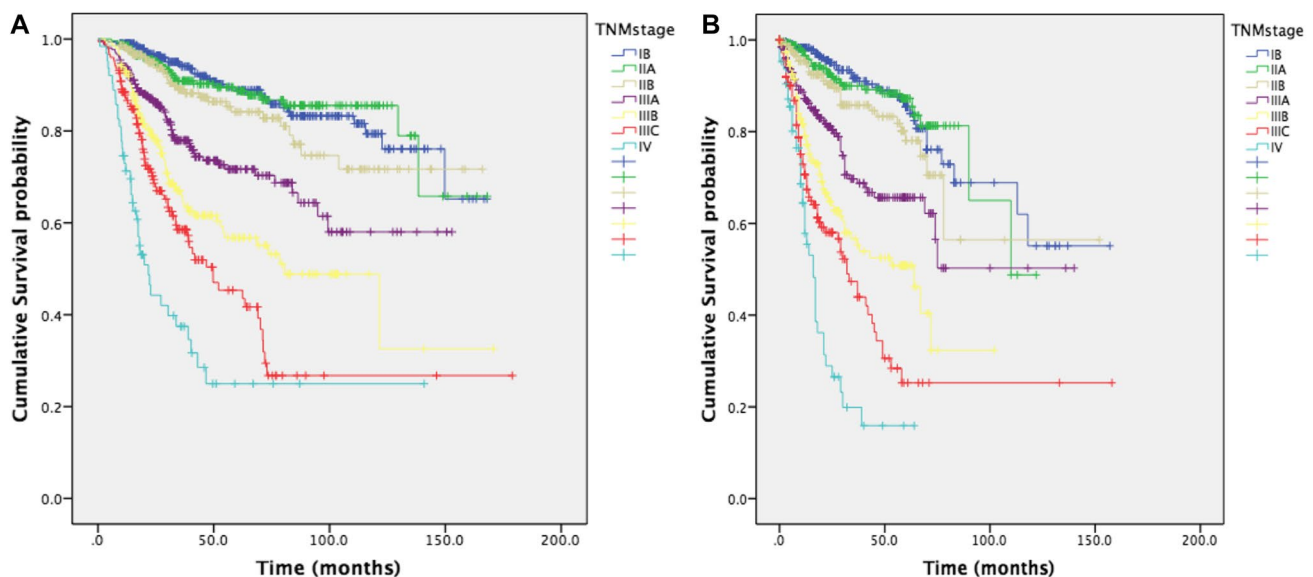

Fig. 1 Kaplan–Meier survival curve after laparoscopic gastrectomy. **A** 5-year overall survival; **B** 5-year disease-free survival

Table 6 Recurrence incidence and patterns

Recurrence	214/1483 (14.4%)
Local recurrence	16 (1.1%)
Remnant stomach	5 (0.3%)
Anastomosis	3 (0.2%)
Regional LN	8 (0.5%)
Distant metastasis	198 (13.3%)
Peritoneum	78 (5.2%)
Liver	35 (2.4%)
Bone	14 (0.9%)
Lung	6 (0.4%)
Colon	12 (0.8%)
Ovary	13 (0.9%)
Paraaortic LN	32 (2.2%)
Other organs	8 (0.5%)

Discussion

While the incidence has been decreasing, gastric cancer is the fifth most frequently diagnosed cancer and the third leading cause of cancer death worldwide [15]. Currently, resection with appropriate lymphadenectomy is the only treatment approach that offers a chance of survival for GC patients [12]. The KLASS 01 and JCOG 0703 studies have shown non-inferiority in the safety of LG compared to OG concerning morbidity and mortality for EGC [3, 16, 17]. As for AGC, short-term morbidity, mortality, and long-term survival results of a Chinese randomized controlled trial(CLASS-01) proved LG to be safe. [9, 18].

D2 LND for TG and DG is the general recommendation in AGC [12]. In our study, there were 356 cases (24%) of D1 + LND which were not appropriate for AGC. This was due to technical difficulty during the early years and the changes in guidelines. Fifteen patients who received D1 LND had reasons such as palliative setting, severe medical co-morbidities, and uncontrollable condition under general anesthesia. Theoretically, PG is not indicated for AGC patients. S. Haruta et al. claimed that proximal gastrectomy can be applicable for AGC localized in the upper third of the stomach for less than T3 tumors that were smaller than 4 cm. [20] In our institution, we performed PG for tumors in the upper third of the stomach less than T3 and smaller than 3 cm. In nine patients who were elderly, comorbid patients with large and severe upper third tumors, we performed proximal gastrectomy for better quality of life after surgery.

In retrospective studies, the morbidity rate of LG for AGC ranged from 8 to 24.2% [5–7, 21–23]. Shinohara et al. reported a morbidity rate of 24.2% after LG with D2 LND for AGC (N = 186) and 1.1% (2 patients) of hospital deaths [6]. Inokuchi reported 17% morbidity rate after LG with D2 LND and showed similar types of complications

[24]. Our results showed an overall complication rate of 9.1% (Table 2). Although we could not directly compare the results from different studies, our postoperative 30-day complication rates after LG with D2 lymphadenectomy for AGC showed better results than other studies. Anastomotic leakage, which is one major complication of gastric surgery, should be evaluated specifically. The anastomotic leakage rate in our study was 2.2%, which is within the range of 1.1% to 2.7% of previous reports [6, 21, 23, 25]. In our risk factor multivariate analysis, old age was the only significant value and this coincides with previous studies (Table 3) [26, 27]. In our institution's previous clinical study, we reported that age over 70 was an independent risk factor for complications [8]. Extended surgery is still risky for the elderly especially if it is a difficult, time demanding, laparoscopic case. Finding the optimal choice of surgical access after an appropriate assessment of risks and benefits is important.

Conversion rate is an important index for laparoscopic technique. LG with D2 LND is a demanding procedure and surgeons tend to convert to open if laparoscopy becomes unsafe. Our open conversion rate was 6.8%, with the following reasons: advanced stage (54.1%), uncontrolled bleeding (17.4%), severe adhesion due to previous operation (9.2%), small abdominal cavity (3.7%), unstable vital signs after CO_2 inflation (3.7%), and intraoperative pleural injury during surgery (1.8%). "Advanced stage" includes large, serosa-invading tumors, and tumors invading adjacent structures. Until 2008, if the tumor was exposed to the serosa, open conversion was routinely performed. When we analyzed the cases performed in the recent 5 years, open conversion rate was 3.4%, with advanced stage being the most common reason (1.7%) followed by uncontrolled bleeding (0.9%), severe adhesion (0.4%), unstable vital sign (0.2%), and pleural injury (0.2%). This may be due to the adoption of a standardized laparoscopic technique by the same group of surgeons. Even with many open conversions in the early years, our open conversion rate is comparable to previous reports of 2.2 to 7% [6, 8, 19].

Our survival data showed a comparable 5-year OS and DFS compared to other studies (Table 4). A multicenter retrospective data from Korea reported 5-year OS of 90.5%, 86.4%, 78.3%, 52.8%, 52.9%, and 37.5%, respectively [21]. A recent COATC 1001 study by Park et al. also showed a high 3-year DFS: 94.1% for stage I, 87.6% for stage II, and 56.6% for stage III. According to our data, stage III showed a 5-year OS of 60.3%. However, stage IIIA (71.7%), IIIB (56.8%), and IIIC (45.4%) showed a big difference in survival, so a separate analysis of these stages seems important in survival analysis. All the patients from stage II and above were sent for further chemotherapy consult and 72% (851/1178) subsequently underwent adjuvant chemotherapy. Our chemotherapy rate is low compared to other controlled trials (100%) such as COATC 1001 trials, which is expected in real-world data, but still shows good survival outcome.

There are no reports on survival analysis of LG for stage 4 AGC cases. Gastrectomy was carried out and a minimum of D1 LND was done for all these patients. In cases with paraaortic LN and station 14v metastases, we resected all LNs except for one case of paraaortic LN metastasis due to extensive disease. Aggressive attempts, albeit performed by experienced expert laparoscopic gastric cancer surgeons, to remove the primary tumor and extensive LN dissection, subject to the patients' condition, could have resulted in the high survival rate of 25%. However, caution is required in treating patients with peritoneal seeding. Peritoneal seeding was associated with a significantly lower survival than the other stage 4 patients (5-year OS 13.1% vs. 39.4%, respectively, $P = 0.0136$). Therefore, patient selection is crucial before performing surgery in patients with peritoneal seeding.

In a recent long-term analysis, Li et al. reported recurrence patterns after LG for AGC [28]. Peritoneal recurrence being the most common (12.4%), locoregional recurrence was 10.7%, hematogenous recurrence was 6.1%, multiple patter recurrence was 4.1%, and distant LN metastasis was shown in 2.4%. Also, Kinoshita et al. recently reported 89 cases (89/261, 34%) of recurrence after R0 resection in the LOC-A study, with peritoneal recurrence being the most common also (42/261, 16.1%) [29]. Our study showed a comparable recurrence rate (Table 6). Distant metastasis after LG can be explained by invisible micro-metastasis during or before surgery, but local recurrence is possible associated with the adequacy of surgery. There is a great concern in clinical practice whether the application of LG for AGC has the possibility of malignant cell dissemination and local recurrence [30, 31]. However, our real-life long-term data show comparable results to other studies.

Since this is a retrospective review of hospital medical records, there are limitations. Firstly, the surgical and medical procedures were not standardized for each patient. Surgery quality, anastomosis technique, LND, patient management, and the guidelines for gastrectomy have changed over time. These are huge factors that influence the data, but they are an inescapable part of real-world data and provide a true representation of outcome in a general practice. Secondly, hospital records were not well organized in the early years of our practice. Complications, surgical records, and pathologic LN station division were not always documented clearly. To circumvent this problem with regards to survival and follow-up data, we utilized data obtained from National Statistics Service of Korea which provides reliable data on survival. Thirdly, as surgical volume increased, more surgeons were recruited and involved in the surgery. The surgeons gained experience and procedures became standardized as time passed. Analyzing only the recent few years might help to remove these confounding factors in data analysis, but we wanted to present the real-life experience of our institution in its entirety.

During our 15 years of experience, we have performed 1483 cases of laparoscopic gastrectomy for AGC. With no controlled values nor omitted data, we present in this study our complete dataset. There has been much development of procedures and instruments in the last 15 years. However, our real-life data showed comparable, yet better morbidity and long-term oncologic outcomes, which provides evidence that LG for AGC is safe and feasible in general practice.

Compliance with ethical standards

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