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**Postoperative Complications, Including Minor Complications, Worsen
Prognosis After Laparoscopic Distal Gastrectomy for Gastric Cancer**

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Running title: Negative Impact of Postoperative Complications on Prognosis Following LDG

Abstract

Background/Aim: The relationship between postoperative complications and prognosis after laparoscopic distal gastrectomy (LDG) for gastric cancer (GC) remains controversial. This study evaluated this association using propensity score-matched analysis.

Patients and Methods: We analyzed data of 590 patients who underwent curative LDG for GC at five institutions between January 2018 and December 2024. Patients were categorized into non-complication and complication groups (non-CG and CG, respectively), with complications defined as Clavien–Dindo grade $\geq$ II (CD $\geq$ II). Minor complications were defined as CD grades I or II, and major complications were defined as CD grades $\geq$ III. Propensity score matching (PSM) was performed using the following covariates: age, sex, body mass index,

American Society of Anesthesiologists physical status, extent of lymph node dissection, reconstruction method, Japanese Classification of Gastric Carcinoma stage, neoadjuvant chemotherapy, and adjuvant chemotherapy. Survival curves were compared using the log-rank test, and multivariate analysis was performed using the Cox proportional hazard models.

Results: Overall incidence of postoperative complications (CD $\geq$ II) was 14.9% (88/590 patients). After the PSM (85 pairs), the CG group had a significantly longer postoperative hospital stay than the non-CG group [median (range), 18 (7–110) days vs. 9 (5–18) days; $p < 0.001$]. Five-year overall survival (OS) rate was 90.7% in the non-CG group and 70.4% in the CG group ($p = 0.009$), and 5-year relapse-free survival rate was 87.7% in the non-CG group and 70.9% in the CG group ($p = 0.027$). Multivariable analysis identified age ≥ 80 years, postoperative complications (CD $\geq$ II), and lymph node metastasis (pN) as independent prognostic factors for OS.

Conclusion: Reducing the incidence of postoperative complications (CD $\geq$ II) may improve prognosis in patients with GC undergoing LDG, contributing to better treatment strategies for GC.

Gastric cancer (GC) is the fifth most common malignancy worldwide, and the third leading cause of cancer-related mortality annually (1). Despite significant advancements in multimodal and targeted therapies, gastrectomy remains the primary treatment option for GC. However, postoperative complications, reported at an incidence rate of 12.8–14.0% (2–4), can adversely affect patient's quality of life (QOL), subsequent treatments, and long-term survival (5, 6). Several studies have suggested that postoperative complications negatively affect the oncological prognosis of patients with GC, including reductions in overall survival (OS) and disease-free survival (DFS) (6–13). Since the introduction of laparoscopy-assisted distal gastrectomy for early GC in 1994 (14), advances in surgical equipment and techniques have led to the widespread adoption of laparoscopic gastrectomy (LG). Compared with open gastrectomy, LG offers advantages such as reduced surgical trauma, faster recovery, and comparable feasibility. Numerous studies have demonstrated the non-inferiority of LG to open gastrectomy for GC (15–18). Consequently, LG is now considered a minimally invasive and effective surgical option for both early and advanced GC, providing survival outcomes similar to those of traditional open surgery (19–23). In Japan, the use of laparoscopic techniques has increased substantially, with the

prevalence of LG increasing from 6.6% in 2004 to 64.9% in 2019, while that of open surgery decreasing from 80.8% to 27.6% within the same period (24). This trend reflects a broader shift towards minimally invasive approaches driven by technological advancements and increased surgeon proficiency. However, there have been some reports on the relationship between postoperative complications and prognosis in patients undergoing LG. This study aimed to evaluate the relationship between postoperative complications and prognosis of patients undergoing laparoscopic distal gastrectomy (LDG) for GC. The findings of this study will provide valuable insights for the development of new strategies to improve GC treatment and outcomes.

Patients and Methods

Patients. Patients who underwent LDG for GC at five institutions (the Hokkaido University Hospital, Teine Keijinkai Hospital, Obihiro Kosei General Hospital, Tonan Hospital, and Japanese Redcross Kitami Hospital) between January 2018 and December 2024 were retrospectively reviewed. All the participating institutions are high-volume centers that specialized in LDG for GC. Only patients who underwent curative LDG were included in the analysis. GC was diagnosed

using endoscopy, computed tomography (CT), or endoscopic ultrasonography. Tumor staging was performed according to the Japanese Classification of Gastric Carcinoma (JCGC) (25).

Data collection. Clinicopathological data included age, sex, body mass index (BMI), American Society of Anesthesiologists physical status (ASA-PS), clinical stage, combined resection of other organs, lymph node dissection, reconstruction method, time to recurrence, and prognosis, were collected. Surgical outcomes, such as operation time, estimated blood loss, postoperative complications, and length of postoperative hospital stay, were also recorded. Patients were categorized into non-complication (non-CG) and complication groups (CG) with complications defined as Clavien–Dindo (26, 27) grade $\geq$ II (CD $\geq$ II). Data collection and analysis were approved by the Hokkaido University Hospital Institutional Review Board (No. 024-0219). This study was conducted in accordance with the principles of the Declaration of Helsinki.

Surgical procedure. Type of procedure (resection or reconstruction) was determined based on surgeon's experience and preference, accredited through

the endoscopic surgical skill qualification system of the Japan Society for Endoscopic Surgery (28). If an operating surgeon lacks this qualification, a qualified surgeon supervised the surgery. Extent of lymph node dissection was determined according to the Japanese Gastric Cancer Association guidelines (25). For Billroth I reconstruction, intracorporeal gastroduodenostomy was performed using a linear stapler intracorporeally following the “Delta-shaped anastomosis” technique described by Kanaya (29). Briefly, small incisions were made on the greater curvature of the remnant stomach and posterior tip of the duodenum. After approximating the posterior walls of the gastric remnant and duodenum, the stapler forks were closed and fired to create a V-shaped anastomosis on the posterior wall. Entry site was then closed using similar linear stapler. For the Billroth II reconstruction, a small opening was made in the jejunum on the antimesenteric border 20–30 cm distal to the ligament of Treitz. Another opening was created in the stapling line at the greater curvature of the gastric stump. Intracorporeal side-to-side isoperistaltic gastrojejunostomy with an antecolic approach was performed using a 60 mm linear stapler. The common entry site was closed using 3-0 absorbable suture. Braun anastomosis is not routinely performed. For Roux-en-Y reconstruction, the jejunum was divided at

25–30 cm distal to the ligament of Treitz using a linear stapler. The Roux limb was elevated *via* the antecolic route. Intracorporeal side-to-side isoperistaltic or anti-peristaltic gastrojejunostomy was performed using a 60 mm linear stapler, and the common entry site was closed using a 3-0 absorbable suture or 60 mm linear stapler. An extracorporeal end-to-side jejuno-jejunal anastomosis was created 30 cm distal from the gastrojejunostomy *via* the extended umbilical wound using a 45- or 60-mm linear stapler, or an intracorporeal side-to-side jejuno-jejunal anastomosis was performed. The common entry site was closed using a 3-0 absorbable suture. Mesenteric defects, including the Petersen's defects were routinely closed using a 3-0 non-absorbable suture.

Postoperative follow-up. The patients were monitored every 3 months after surgery. At each visit, hematological evaluations, including tumor marker analysis for carcinoembryonic antigen and carbohydrate antigen 19-9, were performed. Abdominal CT was performed every 6 months or when clinical recurrence was suspected. Gastrointestinal endoscopy was performed at 1, 3, and 5 years postoperatively. Based on this surveillance, data on 5-year OS and relapse-free survival (RFS) were collected. OS was defined as the time from surgery to death

from any cause or interruption of follow-up. RFS was defined as the time from surgery to death due to GC, first recurrence of GC, or interruption of follow-up. Neoadjuvant chemotherapy (NAC) followed by gastrectomy is not the standard treatment for locally advanced GC in Japan. In this study, NAC followed by gastrectomy was performed in patients with advanced GC without distant metastases, obstruction to food passage, or bleeding from a primary tumor. Primary indications for NAC include type 4 or large type 3 disease, clinical T4b disease, and extensive lymph node metastasis. Patients with pathological stage $\geq$ II received adjuvant chemotherapy with either capecitabine and oxaliplatin (XELOX) or fluorouracil, leucovorin, and oxaliplatin (FOLFOX) or TS-ONE®. The attending clinician selected the chemotherapy regimens for both NAC and adjuvant chemotherapy.

Complications. Complications included anastomotic leakage (duodenal stump leakage), anastomotic stricture, anastomotic hemorrhage, intra-abdominal hemorrhage, ileus (gastrointestinal obstruction and delayed gastric emptying), intra-abdominal abscess, peripancreatic fluid collection (pancreatic fistula and deep surgical site infection), lymphatic fistula, wound infection, cardiac

complications, pulmonary complications, urinary and renal complications, hepatobiliary complications, and other complications (30). Anastomotic leakage was defined as disruption of an anastomotic site and/or duodenal stump. Peripancreatic fluid collection was defined as fluid accumulation resulting from pancreatic fistula formation or deep surgical site infection; distinguishing between these conditions is often challenging (31). Delayed gastric emptying was performed in accordance with the International Study Group of Pancreatic Surgery criteria (32). Patients were classified into five groups based on the CD classification of postoperative complications, which ranks complications according to the therapy required for correction: Grade I (minor deviation from the normal postoperative course); Grade II (requiring pharmacological treatment); Grade III (requiring surgical, endoscopic, or radiological intervention); Grade IV (life-threatening complications requiring intensive care management); and Grade V (death) (26, 27). Minor complications were defined as CD grade I or II, and major complications were defined as CD grade $\geq$ III (33).

Statistical analysis. Preoperative information potentially influencing surgical outcomes was identified in a consensus meeting involving surgeons and

statisticians to enable rigorous estimation of propensity scores. Propensity score matching (PSM) was performed using a logistic regression model to mitigate selection bias. Parameters used in the PSM included age, sex, BMI, ASA-PS, extent of lymph node dissection, reconstruction method, Japanese Classification of Gastric Carcinoma stage, NAC, and adjuvant chemotherapy (34). Logit of the propensity score was matched within 0.2 standard deviations of the value, following the recommendations by Austin (35). Categorical variables were analyzed using the chi-square and Fisher's exact tests, and continuous variables were examined using the Mann–Whitney *U* test, both before and after the PSM. Survival curves were generated using the Kaplan–Meier method and compared using the log-rank test. Statistical significance was set at $p < 0.05$. Statistical analyses were performed using JMP® 18.2.0 software (SAS Institute Inc., Cary, NC, USA).

Results

Clinical features and surgical outcomes of the study population. In total, 712 patients were screened. After applying exclusion criteria (≤ 15 harvested lymph nodes, palliative surgery, insufficient extent of lymphadenectomy, resection of

other organs, conversion surgery, emergency surgery, concurrent active cancers, and gastric remnant cancer), 590 patients were included in the analysis. For accurate prognostic evaluation, only patients with >16 dissected lymph nodes were included based on previously established criteria (36). The non-CG and CG comprised 502 and 88 patients, respectively. After the PSM, 85 patients from the non-CG were individually matched with 85 patients from the CG (Figure 1), resulting in a final cohort of 170 patients (85 per group). Table I shows the clinicopathological characteristics and surgical approaches before (n=590) and after (n=170) matching. Surgical outcomes are summarized in Table II. There were no significant differences between the groups in operation time, blood loss, extent of lymph node dissection, reconstruction method, and median number of harvested lymph nodes [operation time: non-CG, 293 min (144–531 min) vs. CG, 284 min (126–511 min); $p=0.564$; blood loss: non-CG, 0 ml (0–600 ml) vs. CG, 0 ml (0–850 ml); $p=0.796$; D1+/D2: non-CG, 57/28 patients vs. CG, 58/27 patients; $p=0.869$; number of harvested lymph nodes: non-CG, 34 (16–97) vs. CG, 37 (17–91), $p=0.520$]. Median postoperative hospital stay was significantly longer in the CG than that in the CG [non-CG: 9 days (5–18 days) vs. CG: 18 days (7–110 days), $p<0.001$]. Incidence rates of complications classified as CD grades II and

III were 14.9% (88/590) and 4.9% (29/590), respectively, before the PSM. Anastomosis-related complications (including leakage, stricture, and hemorrhage) and peripancreatic fluid collection were relatively common. Reoperation was required in 11 (1.9%) patients before the PSM and in nine (5.3%) after the PSM (Table III).

Prognosis. Table IV presents the results of the histological examination of the resected specimens. Pathological JCGC stages were comparable between the two groups (pStage I/II/III: non-CG, 59/16/10 patients vs. CG, 52/19/14 patients; $p=0.504$). Median follow-up durations were 42.1 months in all the patients after PSM, 44.5 months (range=1–83.3 months) in the non-CG, and 37.4 months (range=1–81.9 months) in the CG. During the follow-up period, postoperative recurrence was observed in five (5.9%) patients in the non-CG and eight (9.4%) in the CG, with no statistically significant difference ($p=0.385$). Median time to recurrence did not differ significantly between the groups ($p=0.421$), and there were no notable differences in the sites of recurrence. For all the patients, the 3- and 5-year OS rates were 91.2% and 80.8%, respectively. Specifically, the 3- and 5-year OS rates were 97.4% and 90.7% in the non-CG and 84.1% and 70.4% in

the CG, respectively. Kaplan–Meier analysis of OS indicated a significant difference between the two groups ($p=0.009$; Figure 2A). The 3- and 5-year RFS rates were 87.8% and 79.2%, respectively, with 97.4% and 87.7% in the non-CG and 84.1% and 70.9% in the CG, respectively. Kaplan–Meier analysis of RFS also showed a significant difference between the two groups ($p=0.027$; Figure 2B).

Prognostic factors for OS and RFS. Table V presents the results of univariate and multivariate analyses assessing the risk factors for OS and RFS. In the OS analysis, age ≥ 80 years, postoperative complications (CD $\geq II$), and lymph node metastasis (pN) were identified as independent prognostic factors [for age ≥ 80 years: hazard ratio (HR)=3.082; 95% confidence interval (CI)=1.261–7.524; $p=0.013$; for CD $\geq II$: HR=3.678; 95%CI=1.331–10.162; $p=0.012$; and for pN: HR=3.158; 95%CI=1.241–8.035; $p=0.016$]. In the RFS analysis, age ≥ 80 years, postoperative complications (CD $\geq II$), tumor depth (pT), and pN were identified as independent prognostic factors (for age ≥ 80 years: HR=3.168; 95%CI=1.432–7.001; $p=0.004$; for CD $\geq II$: HR=2.543; 95%CI=1.095–5.905; $p=0.029$; for pT: HR=0.408; 95%CI=0.175–0.951; $p=0.039$; and for pN: HR=2.653;

95%CI=1.137–6.188; $p=0.024$).

Discussion

In this multicenter retrospective study employing PSM analysis, we demonstrated that postoperative complications, including minor complications ($CD \geq II$), significantly prolonged postoperative hospital stay and adversely affected both OS and RFS following LDG for GC.

Since the first report of LG by Kitano *et al.* in 1994 (14), this minimally invasive technique has been widely accepted worldwide as a safe and effective treatment for GC. Recently, LG has been increasingly used for both early and advanced GC because of its documented benefits such as reduced blood loss, less postoperative pain, and earlier return of bowel function (19-23). Regarding postoperative complications, the JLSSG0901 randomized clinical trial showed no significant difference in severe postoperative complications between open distal gastrectomy and laparoscopy-assisted distal gastrectomy groups (4.7% vs. 3.5%; $p=0.64$). This finding is consistent with those of other large randomized trials in Japan and East Asia, indicating that LG performed by experienced surgeons is as safe as open gastrectomy (19). However, few studies have

explored the relationship between postoperative complications after LG and oncological prognosis in patients with GC (13, 34, 37, 38), and its impact remains unclear. Most reports indicate that major complications ($CD \geq III$) negatively influence prognosis (13, 34, 37, 38). In our PSM analysis of patients with major complications, although the sample size was small ($n=28$), a significant difference was observed in OS ($p=0.011$) but not in RFS ($p=0.274$). Furthermore, our study highlights that even relatively minor complications ($CD \geq II$) may adversely affect prognosis in patients undergoing LDG for GC. These results emphasize the importance of minimizing postoperative complications, including minor ones, to improve long-term outcomes.

Several mechanisms have been proposed to explain this association. Postoperative complications can trigger systemic inflammatory responses, leading to immunosuppression, which may promote tumor recurrence and metastasis. Severe complications induce prolonged inflammation, fasting, and weight loss, all of which contribute to immune dysfunction. Specifically, cytotoxic T lymphocytes and natural killer cells are impaired by systemic inflammation and surgical stress, facilitating immune evasion by micrometastatic cancer cells (39, 40). Moreover, inflammation-related mediators, such as interleukin-1, interleukin-

6, and tumor necrosis factor-alpha, released during infectious complications accelerate residual tumor cell proliferation and invasion (41, 42). Kubota *et al.* reported that infectious complications independently correlate with reduced survival in patients with GC (43), and Tokunaga *et al.* found that postoperative intra-abdominal infectious complications predicted poorer OS (44). However, in our study, no significant differences were observed in the median time to recurrence ($p=0.421$) or the sites of recurrence between patients with and without intra-abdominal infectious complications. In this study, we examined the impact of type of complication on prognosis; however, the trends and characteristics were unclear. We believe that this should be verified by further accumulation of cases in the future. Therefore, efforts to minimize postoperative inflammatory responses are crucial for improving prognosis, underscoring the importance of ensuring surgical safety for both short- and long-term outcomes in patients with GC.

Second, the discrepant findings in some studies may be attributed to interference in the administration of adjuvant chemotherapy. Both postoperative complications and omission of adjuvant therapy significantly increased the risk of death and recurrence. Notably, decreased OS and RFS rates were not observed

in patients who experienced complications but received adjuvant chemotherapy (45). Delays in chemotherapy initiation are correlated with worse outcomes (46). Thus, prophylactic NAC may mitigate the adverse prognostic effects of postoperative complications. Eto *et al.* demonstrated comparable 5-year RFS between patients with and without postoperative complications after NAC and gastrectomy (47). Postoperative complications may prolong hospitalization and lead to delays or omission of adjuvant chemotherapy (48), further worsening survival outcomes after LG for GC (34). In our cohort, among patients with pathological stage II or III disease after PSM, 20.2% with CD grade $\geq$ II complications and 12.5% with CD grade $\geq$ III complications did not receive appropriate adjuvant chemotherapy. Both the CG and non-CG groups had cases in which adjuvant chemotherapy was indicated but not administered (11.3% vs. 16.6%; $p=0.119$), suggesting that postoperative complications may hinder adjuvant treatment delivery. Complications negatively affect nutritional status and physical function, reduce tolerance to further treatments, and impair recovery (49, 50), thereby limiting chemotherapy administration. Previous studies have also linked gastrectomy-associated weight loss with deteriorated nutritional status, reduced postoperative QOL, and decreased compliance with S-1 adjuvant

chemotherapy, which negatively affects prognosis (51, 52). Reported body weight loss at 1 year postoperatively is approximately 10% after distal and 15% after total gastrectomy (53–55). The mechanisms include hypercatabolism due to inflammation from surgical stress, reduced intake due to loss of gastric reservoir function, and decreased circulating ghrelin levels (56). Anastomotic complications are likely to exacerbate decreased oral intake and cause significant weight loss. Jejunostomy feeding after gastrectomy has been shown to improve nutritional status and reduce postoperative morbidity (57). A subgroup analysis by Li *et al.* showed no significant difference in 5-year OS, DFS, and DSS between CD grade II complication and non-complication groups among patients with stage I or II disease, suggesting that minor complications may not strongly affect prognosis in early-stage GC (11). However, our data indicate that CD grade II complications adversely affect the survival of patients with stage III disease. Given that our cohort included patients with advanced cancer, postoperative complications are likely to exert a more direct influence on prognosis in this population. Therefore, it is critical to reduce the incidence of complications in patients with advanced GC. Similarly, Duraes *et al.* reported that even minor complications (CD grade II) compromise oncological outcomes after colorectal cancer surgery (58). This

finding supports the concept that postoperative complications, including relatively minor ones, are poor prognostic factors for tumor outcomes. In this study, a more granular comparison of prognosis by CD grades II and III factors is warranted; however, the limited number of CD grade III cases (28 of 170, 16.5%) restricts such analyses. We plan to accumulate additional cases for a detailed prognostic assessment in future studies. Although further case selection is necessary, consideration should be given to the indications for NAC, as well as the establishment of an enteral feeding tube to maintain post-operative nutritional status.

Recently, robotic gastrectomy (RG) has gained attention, with reports focusing on complication rates. Multi-institutional studies have indicated that RG may reduce certain postoperative complications compared with LG for clinical stage I/II GC. Although overall morbidity rates did not differ significantly between RG and LG, RG was associated with lower rates of anastomotic leakage and intra-abdominal abscesses, reduced estimated blood loss, and shorter postoperative hospitalization. Such findings likely reflect improved precision and dexterity afforded by robotic systems (59).

The strengths of our study include its multicenter design, large sample size,

and use of PSM to minimize selection bias. Limitations of this study include its retrospective nature, potential information bias, relatively short median follow-up period of 42.1 months, and confinement to high-volume Japanese centers, which may limit its external generalizability. Although the 5-year survival estimates are provisional, the Kaplan–Meier analyses suggested proportional hazards between the groups, supporting the persistence of observed differences with longer follow-up period. Continued surveillance is necessary to confirm these findings.

Postoperative complications, including relatively minor complications of CD $\geq$ II, had a significant negative impact on prognosis after LDG for GC. Efforts to reduce the incidence of postoperative complications may help improve prognosis in patients with GC undergoing LDG, which can contribute to the development of better treatment strategies for GC.

Conflicts of Interest

The Authors declare no conflicts of interest in relation to this study.

Authors' Contributions

Study conception and design: Yuma Ebihara and Noriaki Kyogoku; Acquisition of

data: Yuma Ebihara; Analysis and interpretation of data: Yuma Ebihara and Noriaki Kyogoku; Drafting of manuscript: Yuma Ebihara; Critical revision of the manuscript: Yuma Ebihara, Noriaki Kyogoku, Hironobu Takano, Hideyuki Wada, Takeo Nitta, Daisuke Saikawa, Yoshiyuki Yamamura, Minoru Takada, Toshiaki Shichinohe, and Satoshi Hirano.

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Artificial Intelligence (AI) Disclosure

No artificial intelligence (AI) tools, including large language models or machine learning software, were used in the preparation, analysis, or presentation of this manuscript.

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Figure Legends

Enrollment

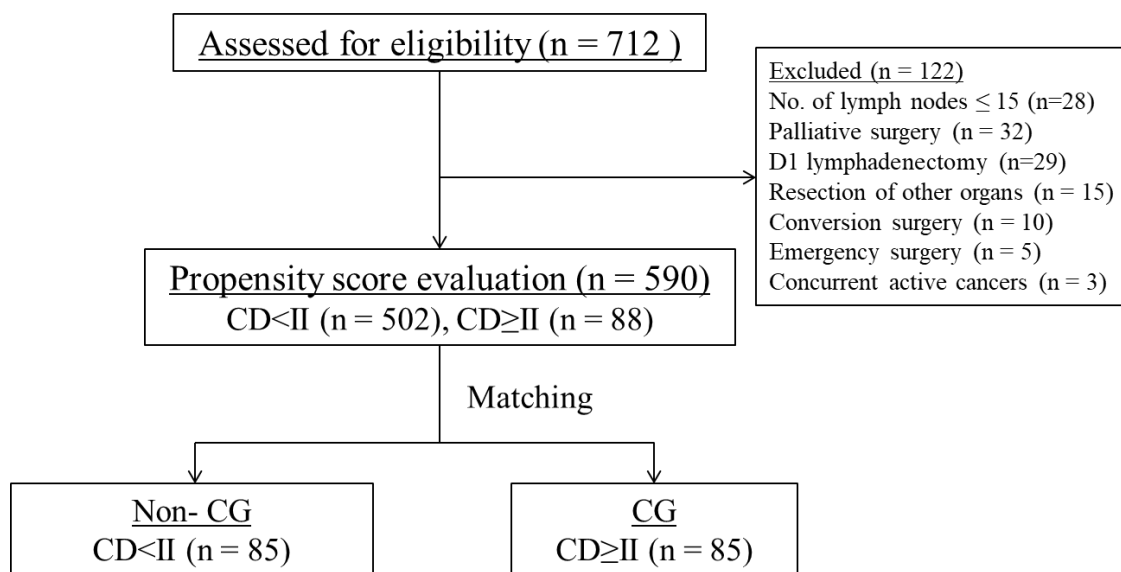
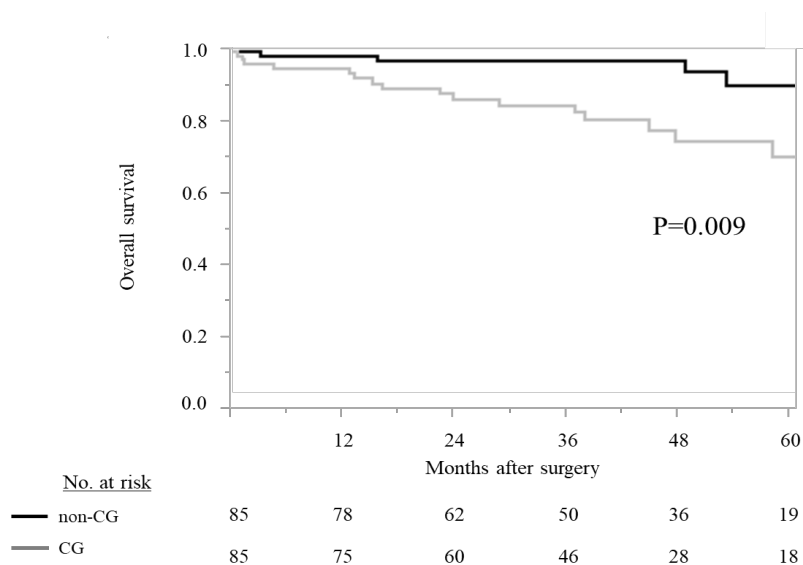


Figure 1. Study enrollment for patients who underwent laparoscopic distal gastrectomy for gastric cancer. In this study, for accurate prognostic analysis, patients with ≤ 15 dissected lymph nodes were excluded. Patients were categorized into a non-complication group (non-CG) and a complication group (CG), with complications defined as CD grade $\geq \text{II}$ ($\text{CD} \geq \text{II}$). CD: Clavien–Dindo grade.

(A) Overall survival



(B) Relapse-free survival

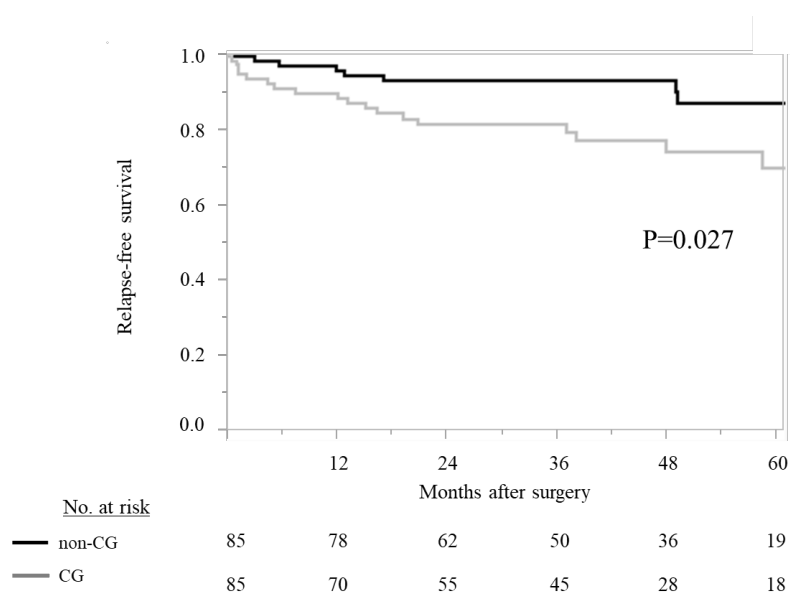


Figure 2. Prognosis of patients who underwent laparoscopic distal gastrectomy for gastric cancer (GC) according to postoperative complications (non-CG; non-complication group, CG; complication group) after propensity score matching

Table I. Patient characteristics who underwent laparoscopic distal gastrectomy before and after propensity score matching.

	All patients (n=590)			Propensity-matched patients (n=170)		
	non-CG (n=502)	CG (n=88)	<i>p</i> -Value	non-CG (n=85)	CG (n=85)	<i>p</i> -Value
Age, median (range)	72 (28-91)	73 (29-91)	0.091	72 (38-88)	73 (29-91)	0.554
Sex (%)			0.013			0.862
Male	309 (61.6)	66 (75.0)		62 (72.9)	63 (74.1)	
Female	193 (38.4)	22 (25.0)		23 (27.1)	22 (25.9)	
BMI (kg/m ²), median (range)	22.9 (14.8-41.8)	23.0 (15.1-32.8)	0.829	23.3 (16.5-31.6)	23.0 (15.1-32.8)	0.720
ASA-PS (%)			0.501			0.464
1-2	441 (87.8)	75 (85.2)		77 (90.6)	74 (87.1)	
3-4	61 (12.2)	13 (14.8)		8 (9.4)	11 (12.9)	
Clinical JCGC stage* (%)			0.125			0.311
I	359 (71.5)	58 (65.9)		65 (76.5)	57 (67.0)	
II	89 (17.7)	15 (17.1)		12 (14.1)	14 (16.5)	
III	54 (10.8)	14 (15.9)		8 (9.4)	14 (16.5)	
IV	0	1 (1.1)		0	0	

BMI: Body mass index; ASA-PS: The American Society of Anaesthesiologist's physical status; *According to the Japanese classification of gastric carcinoma: 3rd English edition.

Table II. Surgical outcomes and postoperative course in patients who underwent curative minimally invasive distal gastrectomy before and after propensity score matching.

	All patients (n=590)			Propensity-matched patients (n=170)		
	non-CG (n=502)	CG (n=88)	<i>p</i> -Value	non-CG (n=85)	CG (n=85)	<i>p</i> -Value
Operation time (min), median (range)	270 (126-531)	283 (126-511)	0.036	293 (144-531)	284 (126-511)	0.564
Blood loss (ml), median (range)	0.5 (0-1048)	0 (0-850)	0.587	0 (0-600)	0 (0-850)	0.796
Extent of lymph node dissection (%)			0.621			0.869
D1+	361 (71.9)	61 (69.3)		57 (67.1)	58 (68.2)	
D2	141 (28.1)	27 (30.7)		28 (32.9)	27 (31.8)	
Reconstruction			0.003			0.846
Billroth I	225 (44.8)	26 (29.6)		27 (31.8)	26 (30.6)	
Billroth II	73 (14.6)	9 (10.2)		10 (11.8)	8 (9.4)	
Roux-en-Y	204 (40.6)	53 (60.2)		48 (56.4)	51 (60.0)	
Number of harvested lymph nodes, median (range)	40 (16-115)	37 (17-91)	0.097	34 (16-97)	37 (17-91)	0.520
Postoperative hospital stay (day), median (range)	9 (4-27)	18 (7-110)	<0.001	9 (5-18)	18 (7-110)	<0.001

Mortality (within 30 days)

0

3

0

3

Table III. Postoperative complication types.

	All patients (n=590)			Propensity-matched patients (n=170)		
	All grades	≥ II	≥ III	All grades	≥ II	≥ III
Anastomotic leakage	13	13	9	12	12	8
Anastomotic stricture	1	1	0	1	1	0
Anastomotic hemorrhage	5	4	3	4	4	3
Intra-abdominal hemorrhage	6	6	2	6	6	2
Ileus (including DGE)	19	14	2	14	14	2
Intra-abdominal abscess	11	10	2	10	10	2
Peripancreatic fluid collection	21	20	8	20	20	8
Lymphatic fistula	1	1	0	1	1	0
Wound infection	3	2	0	2	2	0
Cardiac complications	1	1	0	0	0	0
Pulmonary complications	6	5	1	4	4	1
Urinary and renal complication	5	3	0	4	3	0
Hepatobiliary complications	2	2	1	2	2	1
Other	10	6	1	6	6	1
All (%)	104 (17.6)	88 (14.9)	29 (4.9)	86 (50.6)	85 (50.0)	28 (16.5)
Reoperation (%)		11 (1.9)			9 (5.3)	
DGE: Delayed gastric emptying.						

Table IV. Characteristics of patients who underwent laparoscopic distal gastrectomy before and after propensity score matching.

	All patients (n=590)			Propensity-matched patients (n=170)		
	non-CG (n=502)	CG (n=88)	<i>p</i> -Value	non-CG (n=85)	CG (n=85)	<i>p</i> -Value
Pathological JCGC stage* (%)			0.829			0.504
I	323 (64.3)	54 (61.3)		59 (69.4)	52 (61.2)	
II	105 (20.9)	19 (21.6)		16 (18.8)	19 (22.4)	
III	74 (14.8)	15 (17.1)		10 (11.8)	14 (16.4)	
Neoadjuvant chemotherapy	2 (0.3)	0		0	0	
Adjuvant chemotherapy (%)	103 (20.5)	13 (14.7)	0.198	6 (7.1)	13 (15.3)	0.085
Recurrence (%)	45 (9.0)	9 (10.2)	0.709	5 (5.9)	8 (9.4)	0.385
Days until recurrence (day), median (range)	390.0 (28-1534)	233 (41-652)	0.260	402 (181-1534)	305 (41-652)	0.421
Recurrence site						
LN (Para Ao/Distant)	13	0		3	0	
Peritoneum dissemination	17	3		1	3	
Liver metastasis	6	4		0	4	
Lung metastasis	1	1		0	0	
Bone metastasis	1	0		0	0	
Skin metastasis	1	0		0	0	

Anastomotic lesion (remnant stomach)	5	1	1	1
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*According to the Japanese classification of gastric carcinoma: 3rd English edition.

Table V. Univariate and multivariate Cox regression analyses for overall survival/relapse-free survival after propensity score matching.

	Overall survival				Relapse-free survival			
	Univariate analysis		Multivariate analysis		Univariate analysis		Multivariate analysis	
	HR (95%CI)	<i>p</i> -Value	HR (95%CI)	<i>p</i> -Value	HR (95%CI)	<i>p</i> -Value	HR (95%CI)	<i>p</i> -Value
Age (year) (≥ 80 / < 80)	3.078 (1.270-7.457)	0.012	3.082 (1.261-7.524)	0.013	3.346 (1.523-7.352)	0.002	3.168 (1.432-7.001)	0.004
Postoperative complication (CD $\geq$ II / CD $<$ II)	3.511 (1.284-9.594)	0.014	3.678 (1.331-10.162)	0.012	5.395 (1.181-24.631)	0.029	2.543 (1.095-5.905)	0.029
pT (1,2 / 3,4)	0.395 (0.167-0.931)	0.033			0.258 (0.118-0.563)	<0.001	0.408 (0.175-0.951)	0.039
pN (Y / N)	3.337 (1.414-7.873)	0.006	3.158 (1.241-8.035)	0.016	3.592 (1.659-7.776)	0.001	2.653 (1.137-6.188)	0.024
CD: Clavien-Dindo classification.								