Oncological Outcomes of Laparoscopic Versus Open Gastrectomy After Neoadjuvant Chemotherapy for Locally Advanced Gastric Cancer: A Retrospective Multicenter Study

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Abstract

Background: Oncological outcomes of laparoscopic gastrectomy (LG) and open gastrectomy (OG) following neo-adjuvant chemotherapy were investigated in few studies. Our purpose was to evaluate the oncological outcomes of LG and OG after neoadjuvant chemotherapy for patients with locally advanced GC to determine its safety and feasibility.

Methods: We conducted a retrospective chart review for all patients who underwent either OG (n = 43) or LG (n = 41). The neoadjuvant treatment regimen consisted of capecitabine plus oxaliplatin for 3 cycles, which was then repeated for 5 cycles 6 to 12 weeks after the operation.

Results: The hospital stay length and intraoperative blood loss the LG group were significantly lower than in the OG group. The in-hospital mortality rate and the 3-year survival rate for patients in the OG group were comparable to that of patients in the LG group (4.6% vs 9.7%; 58.1% vs 68.3%, respectively). Similar trends were observed regarding the 3-year recurrence rate and metastasis. The mean survival time was 52.9 months (95% confidence interval [CI], 44.2–61.6) in the OG group compared with 43.3 (95% CI, 36.6–49.8) in the LG group. Likewise, the mean disease-free survival was 56.1 months (95% CI, 46.36–65.8) in the LG group compared with 50.9 months (95% CI, 44.6–57.2) in the OG group.

Conclusion: Compared to OG, LG is a feasible and safe alternative for patients receiving neoadjuvant chemotherapy with locally advanced GC.

Introduction

Affecting more than 950,000 patients annually, gastric cancer (GC) is the fifth most prevalent cancer and the world's third most common cause of cancer-related death [1–3]. Epidemiological studies have shown that the overall incidence of GC is decreasing, likely as lifestyle changes are occurring, such as lower salted and preserved food intake, and reduced Helicobacter pylori [4,5]. Advanced GC is identified when the tumor invades the submucosa [6]. According to the gastric staging system of the American Joint Committee on Cancer, metastatic GC is stage IV [7,8]. The 5-year survival after diagnosis is ranging from 70–5% for stage Ia to stage IV, respectively [9]. In addition, choosing the treatment strategy, such as potentially curative treatment, endoscopic treatment, or palliative treatment, depends on the stage of the disease.

Laparoscopic gastrectomy (LG) is one of the standard procedures for early GC and has proven its feasibility in local advanced GC [10–12]. Owing to its low invasiveness, shorter length of hospitalization, faster bowel movement recovery, and good cosmetic outcomes, LG has recently gained great popularity for the management of early GC [13–15]. Many systematic reviews proved the feasibility of LG compared with open gastrectomy (OG) in GC patients [16–18]. Disturbance of intraoperative circulatory and respiratory dynamics, in addition to prolonged-time of operation, are the main issues regarding LG [19]. Therefore, there is a lack of evidence regarding its oncological safety. The majority of randomized clinical trials

(RCT) that compared LG and OG for early GC have reported early findings in the procedural safety of the laparoscopic method and short-term benefits [20–22]. In terms of advanced GC, there is no sufficient evidence comparing LG and OG, particularly in patients undergoing neoadjuvant chemotherapy.

On the other hand, a multimodality approach is the cornerstone for management of patients with advanced GC. Currently, adjuvant chemotherapy is the modality recommended by both the Asian and American guidelines [23]. Recently, neoadjuvant chemotherapy has been proposed as a promising approach to improve survival compared with adjuvant modality. Several phase III European studies have demonstrated that the administration of neoadjuvant chemotherapy prior to curative surgery and adjuvant chemotherapy in GC patients has increased their survival rates [24,25]. Another theoretical advantage is the greater probability of successful completion of a multimodality approach when chemotherapy is given before the development of possible postoperative complications with extended surgery [26]. In some patients, postoperative adjuvant chemotherapy is restricted owing to surgical complications [27].

There is an increasing interest in the safety and efficacy of LG after neoadjuvant chemotherapy. However, few studies have investigated the oncological outcomes by comparing LG and OG after neoadjuvant chemotherapy. Edema and tissue fibrotic changes induced by chemotherapy present new technical challenges for laparoscopic treatments [28,29]. Nevertheless, many investigators have excluded patients receiving chemotherapy from studies of LG in GC. Therefore, we aimed to investigate the oncological outcomes of LG for patients with locally advanced GC after neoadjuvant chemotherapy to determine its safety and feasibility.

Materials And Methods

We conducted a retrospective chart review of all adult patients (≥18 y) of both sexes who were diagnosed with locally advanced gastric cancer and underwent either OG or LG during the period from January 2015 to January 2017 at Suez Canal University Hospital and Cairo University Hospitals. We excluded patients who required conversion to open surgery and patients with distant metastasis or other primary malignancies. The study’s protocol received ethical approval from the responsible steering committee.

Preoperative Staging

Preoperatively, we conducted a full history-taking and thorough clinical examination for all patients. In addition, we collected the findings of routine laboratory investigations, contrast-enhanced abdominal computed tomography, and upper endoscopy with tissue biopsy. Patients were clinically staged according to the TNM classification, 7th Edition [30]. The neoadjuvant treatment regimen consisted of capecitabine (500 mg/m^2 orally 2 times a day) plus oxaliplatin (130 mg/m^2) for 3 cycles (21 days in each cycle). This was repeated for 5 cycles 6 to 12 weeks after the operation. The radiological response to neoadjuvant chemotherapy was assessed according to the Response Evaluation Criteria in Solid

Tumors (version 1.1) [31]. On the other hand, the severity of chemotherapy-associated adverse events was assessed based on the recommendations of the Common Terminology Criteria for Adverse Events (version 4.0) [32].

Surgical Technique

The surgery was performed within 4 to 6 weeks from the completion of chemotherapy. Prophylactic antibiotics were given simultaneously after general anesthesia to all patients, and the insertion of Foley's catheter was commenced.

A standard LG or OG with proper lymphadenectomy (including lymph nodes 1–9, 11p, and 12a in D2 lymphadenectomy and 1–8a and 12a in extended D1 lymphadenectomy) was performed by an experienced surgeon, according to the Japanese classification of gastric carcinoma [33].

The patients were then divided into OG or LG groups, and an initial exploration was conducted to assess the feasibility of resection. In the OG group, a 20- to 25-cm midline incision was made from the xiphoid process to the periumbilical area. In the LG group, 4 mm ports were inserted periumbilical in the left upper quadrants and the right and left flank areas, respectively. Another 5 mm port was inserted in the right upper quadrants. In both groups, the decision to perform subtotal or total resection was based solely on the tumor site and extent. In cases of involvement of upper one-third of greater curvature, the spleen was resected. Roux-en-Y procedures, with functional side-to-side anastomosis, were performed to restore the continuity of the gastrointestinal tract. The specimen was pulled out through a small median incision under the xiphoid (approximately 6–8 cm).

Postoperative management was done according to participating hospitals' guidelines. Patients were discharged after more than 2 days of soft diet without fever or abdominal pain. The adjuvant regimen started on the beginning of the seventh postoperative week and consisted of oxaliplatin plus capecitabine for 5 cycles. Dose reduction or treatment discontinuation were attempted in cases of serious adverse events. In addition, oxaliplatin was stopped in the case of neurological complications. Palliative and supportive care were offered as needed for disease-related symptoms.

Follow-Up and Study Outcomes

Patients were followed up during their hospital stay and up to years after the procedure. The primary outcome in the present study was to compare the 3-year survival rate and overall survival (OS) between the LG and OG groups. Secondary outcomes included survival time, 3-year recurrence rate, disease progression-free survival (DFS), operative time, intraoperative blood loss, hospital stay, and postoperative complications. The grade of complications was assessed using Clavien-Dindo grades, in which 1 of 7 grades was allocated according to the type of management of the complication [34].

Statistical Analysis

Statistical data analysis was conducted using Microsoft Excel 2013 (Microsoft Corp., Redmond, WA) 32-bit software. Continuous data were expressed as means (± standard deviation [SD]), and categorical data were described as percentages. Comparisons between qualitative data was performed using the chi-square or Fisher's exact tests, whereas comparisons between quantitative data were performed using the Mann-Whitney or analysis of variance tests. A *P* value of less than 5% was considered statistically significant.

Results

A total of 96 patients were initially screened for inclusion in this study. Six patients were excluded owing to palliative surgery for peritoneal dissemination, and 90 patients were ultimately selected and divided in a 1:1 ratio between LG or OG. The data of 84 patients (43 OG and 41 LG) were available for statistical analysis (Fig. 1). The mean age of the included patients was 64 ± 10.7 years in the OG group and 62.29 ± 4.5 years in the LG group ($P = 0.45$). There was male predominance in the OG group (60.5%; $P = 0.29$). Additionally, there were no significant differences between the groups in terms of site of tumor ($P = 0.36$), tumor differentiation ($P = 0.15$), and clinical stage ($P = 0.52$). On the other hand, the frequency of complete radiological response was significantly higher in the OG group (39.5% vs 24.4%; $P = 0.002$) (Table 1).

Table 1
Preoperative data of the studied groups

Variables	OG Group (n = 43)	LG Group (n = 41)	*P* value
Age (mean ± SD), y	64 ± 10.7	62.29 ± 4.5	0.45
Male, no (%)	26 (60.5%)	20 (48.8%)	0.29
Site of tumor	6 (14%)	9 (22%)	0.28
• Esophagogastric junction	2 (4.7%)	4 (9.8%)	
• Fundus	21 (48.8%)	11 (26.8%)	
• Body	12 (27.9%)	13 (31.7%)	
• Antrum	2 (4.7%)	4 (9.8%)	
• Pylorus			
Tumor differentiation	8 (18.6%)	4 (9.8%)	0.15
• Well	10 (23.3%)	15 (36.6%)	
• Moderate	22 (51.2%)	22 (53.7%)	
• Poor			
Stage of tumor	15 (34.9%)	15 (36.6%)	0.52
• II	28 (65.1%)	26 (63.4%)	
• III			
T stage	12 (27.9%)	10 (24.3%)	0.56
• T2	17 (39.5%)	20 (48.7%)	
• T3	11 (47.2%)	11 (26.8%)	
• T4a	3 (6.9%)	0 (0.0%)	
• T4b			
N stage	12 (27.9%)	21 (51.2%)	0.14
• N0	9 (20.9%)	9 (22%)	
• N1	10 (23.3%)	7 (17.1%)	
• N2	8 (18.6%)	4 (9.8%)	
• N3a	3 (7%)	0 (0.0%)	
• N3b			

Variables	OG Group (n = 43)	LG Group (n = 41)	*P* value
Radiological response	17 (39.5%)	10 (24.4%)	0.002*
• CR	14 (32.6%)	9 (22.0%)	
• DP	12 (27.9%)	10 (24.4%)	
• SD			

In terms of intraoperative characteristics, the amount of intraoperative blood loss was significantly lower in the LG group than in the OG group (157.2 ± 17.6 vs 70.5 ± 28.12; *P* = 0.012). No significant differences were detected between the OG and LG groups regarding the duration of operation (*P* = 0.202), technique (*P* = 0.19), margin of resection (*P* = 0.64), number of total lymph nodes (*P* = 0.17), and number of positive lymph nodes (*P* = 0.14) (Table 2).

Table 2
Intraoperative data of the included patients

Variables	OG Group (n = 43)	LG Group (n = 41)	*P* value
Duration of operation, min (mean ± SD)	279.88 ± 70.8	297.8 ± 56.2	0.202
Technique, no. (%) • Distal subtotal • Total	16 (37.2%) 27 (62.8%)	15 (36.6%) 26 (63.4%)	0.19
Margin of resection, no. (%) • R0 • R1	40 (93%) 3 (7%)	37 (90.2%) 4 (9.8%)	0.64
Type of positive margin, no. (%) • Proximal • Distal	2 (4.7%) 1 (2.3%)	2 (4.9%) 2 (4.9%)	0.78
Lymphadenectomy type, no. (%) • D1+ • D2 • D2+	16 (37.2%) 21 (48.8%) 6 (14%)	16 (39%) 22 (53.6%) 3 (7.3%)	0.142
Blood loss, mL (mean ± SD)	157.2 ± 17.65	70.5 ± 28.12	0.012
No. of total lymph nodes (mean ± SD)	27.6 ± 16.5	21.6 ± 10.3	0.17
No. of positive lymph nodes (mean ± SD)	4.4 ± 8	2.9 ± 4.4	0.14

The hospital stay was significantly shorter in the LG group than in the OG group (4.75 ± 5.17 vs 8.11 ± 2.44; *P* = 0.026). Patients in the OG group showed a rate of in-hospital mortality comparable to patients in the LG group (4.6% vs 9.7%; *P* = 0.36). Septic peritonitis and anastomosis leakage were the causes of death in 2 patients in the LG group, whereas the cause of death was general in the rest of the patients. On the other hand, patients in the LG group showed a lower rate of postoperative complications. However, this did not reach the level of statistical significance (*P* = 0.16). The types of postoperative complications were comparable between both groups (*P* = 0.128). Patients in the LG group were less likely to experience high Clavien-Dindo grades than patients in the OG group (*P* = 0.026) (Table 3).

Table 3
Postoperative data of the included patients

Variables	**OG Group (n = 43)**	**LG Group (n = 41)**	***P* value**
Hospital stay, d (mean ± SD)	8.11 ± 2.44	4.75 ± 5.17	0.026
In-hospital mortality, no. (%)	2 (4.6%)	4 (9.7%)	0.36
Postoperative complications, no. (%)	8 (18.6%)	7 (17.1%)	0.16
Type of surgical complications, no. (%) • Abdominal collection • Esophagojejunal leak • Gastrointestinal bleeding • Wound infection • Intrapritoneal bleeding • Pancreatic leak	0 (0.0%) 4 (9.8%) 1 (2.4%) 0 (0.0%) 1 (2.4%) 1 (2.4%)	2 (4.7%) 3 (7%) 0 (0.0%) 0 0 (0.0%) 2 (4.7%)	0.128
Type of medical complications, no. (%) • Urinary tract infection • Enteritis • Gastrointestinal bleeding • Pleural effusion • Pulmonary embolism • Sepsis	2 (4.6%) 1 (2.3%) 0 (0.0%) 3 (7%) 1 (2.3%) 0 (0.0%)	0 (0.0%) 0 (0.0%) 1 (2.4%) 1 (2.4%) 0 (0.0%) 1 (2.4%)	0.227
Clavien-Dindo class, no. (%) • Grade II • Grade IIIA • Grade IIIB • Grade IVA • Grade V	2 (4.9%) 1 (2.4%) 2 (4.9%) 1 (2.4%) 2 (4.9%)	8 (18.6%) 4 (9.3%) 0 (0.0%) 0 (0.0%) 0 (0.0%)	0.026
Reintervention,, no. (%)	2 (4.7%)	2 (4.9%)	0.96

Regarding long-term outcomes, the 3-year survival rate was comparable between the OG and LG groups (58.1% vs 68.3%; $P = 0.23$). Similar trends were observed regarding the 3-year recurrence rate ($P = 0.15$)

and metastasis (P = 0.26) (Table 4). The mean survival time was 52.9 months (95% CI, 44.2–61.6) in the OG group compared with 43.3 months (95% CI, 36.6–49.8) in the LG group (P = 0.96) (Fig. 2). Likewise, the mean DFS was 56.1 months (95% CI, 46.36–65.8) in the LG group compared with 50.9 months (95% CI, 44.6–57.2) in the OG group (P = 0.218) (Fig. 3).

Table 4
3-year outcomes of the included patients

Variables	OG Group (n = 43)	LG Group (n = 41)	*P* value
Metastasis, no. (%)	8 (18.6%)	2 (4.9%)	0.26
• Locoregional	1 (2.3%)	1 (2.4%)	
• Liver	4 (9.3%)	2 (4.9%)	
• Carcinomatosis	1 (2.3%)	0 (0.0%)	
• Anastomosis			
Recurrence (No, %)	13 (30.3%)	6 (14.6%)	0.15
Overall Survival (No, %)	25 (58.1%)	28 (68.3%)	0.23

Cox regression analysis demonstrated that none of the perioperative characteristics was an independent predictor of OS. On the other hand, age younger than 70 years old (hazard ratio, 0.015; 95% CI, 0–0.65) was an independent predictor of favorable DFS (Table 5).

Table 5
Cox regression analysis of predictors of OS and DFS

Variables	OS		DFS	
	HR (95% CI)	P value	HR (95% CI)	P value
Age (< 70 vs ≥ 70 y)	1.45 (0.523–4.1)	0.47	0.015 (0–0.65)	0.023
Sex (male vs female)	2.69 (0.81–8.91)	0.105	0.084 (0.004–1.6)	0.106
Differentiation (well vs moderate-to-poor)	1.4 (0.36–5.72)	0.27	27.538 (0.94–766)	0.054
Tumor stage (II vs III)	0.66 (0.23–1.92)	0.45	0.228 (0.34–1.2)	0.081
Radiological response (CR vs SD/PD)	0.65 (025–1.69)	0.37	0.31 (0.06–2.8)	0.285
Surgical procedure (open vs laparoscopy)	0.46 (0.13–1.68)	0.24	58.8 (0.38–9037.8)	0.113
Type of gastrectomy (distal vs total)	1.63 (0.62–4.29)	0.32	3.9 (0.34–46.45)	0.274
Metastasis (yes vs no)	3.3 (0.85–12.84)	0.08	12708.6 (57–2819349)	0.001
Marginal resection (R0 vs R1)	2.45 (0.29–20.29)	0.41	0.019 (0–2.4)	0.111
Complications (yes vs no)	0.44 (0.12–1.64)	0.22	0.533 (0.04–6.5)	0.622
Reintervention (yes vs no)	35.56 (3.39–372.19)	0.003	2.934	0.997

Discussion

Owing to the aggressive disease, old age in the majority of cases, poor nutrition, extreme radical dissection, and surgical traumas, patients with locally advanced GC are prone to prolonged hospital stay, postoperative morbidity, increased financial burden, and even a high risk of postoperative mortality [35]. Thus, in patients with GC, surgeons must be careful when choosing the treatment strategy [35]. This concept makes LG the fastest growing minimally invasive procedure for patients with GC [36].

Several trials have indicated that LG could provide smaller incisions, reduced bleeding, and decreased surgical stress [37,38]. Despite the great advances in this technique and its impact on oncological outcomes, however, LG has some issues, such as decreased intraoperative compliance of lung owing to the establishment of artificial pneumoperitoneum as well as the relatively long time required for this technique [39]. Some researchers have therefore suggested using neoadjuvant chemotherapy before LG or OG because the application may help prevent an unnecessary procedure by reducing the size of the tumor and making the resection of R0 easier. In addition, micrometastatic tumor cell eradication can begin at an early stage, which is an important advantage over adjuvant chemotherapy [27,40].

Our findings highlighted the impact of LG versus OG in 2 groups of matched patients with GC. In agreement with the literature, our findings showed that LG was associated with a much lower intraoperative blood loss ($P = 0.012$), shorter length of hospital stay ($P = 0.026$), and a lower rate of postoperative complications ($P = 0.16$). On the other hand, the in-hospital mortality rate and types of postoperative complications were comparable in both groups. Regarding long-term outcomes, both groups were comparable in terms of 3-year survival ($P = 0.23$), mean survival time ($P = 0.96$), 3-year recurrence rate ($P = 0.15$), or metastasis ($P = 0.26$). Regarding the DFS, LG had higher DFS, but this was not significant ($P = 0.21$). These findings indicate that LG had more favorable intra- and postoperative outcomes in terms of safety and tolerability. However, the efficacy of LG compared with OG remains controversial.

The Korean Laparoendoscopic Gastrointestinal Surgery Study trial demonstrated that laparoscopic distal gastrectomy and open distal gastrectomy were almost similar in terms of 5-year survival (94.2% vs 93.3%; $P = 0.64$) and 5-year cancer-specific survival rates (97.1% vs 97.2%; $P = 0.91$). Both groups were comparable ($P = 0.49$ and $P = 0.60$, respectively) concerning total deaths and recurrence [37]. The oncological safety of LG for GC was doubted, as the risk of locoregional recurrence was potentially increased owing to insufficient lymphadenectomy [16]. An RCT conducted by Hu et al. showed similar compliance rates of D2 lymphadenectomy between LG and OG (99.4% vs 99.6%; $P = 0.845$), and comparable postoperative morbidity (15.2% vs 12.9%; $P = 0.28$) and mortality (0.4% vs 0%; $P = 0.24$) [41]. In agreement with our findings, Yu et al. showed a similar 3-year DFS rate in LG (76.5%) and OG (77.8%) in patients with locally advanced GC. Furthermore, the 3-year OS rate, recurrence rate, and mortality rate were comparable in both groups ($P = 0.28$, $P = 0.35$, and $P = 0.33$, respectively) [21]. In the retrospective analysis of Fujisaki et al., they reported comparable 5-year DFS (44.4% vs 53.3%; $P = 0.382$) and OS (46.9% vs 54.0%; $P = 0.422$) in LG and OG groups, respectively [42].

Anastomotic leakage and septic peritonitis are considered as major complications of gastric surgery. In our study, these 2 complications were the causes of death in 2 patients in the LG group. The anastomotic rate of leakage in the LG group reported by Hu et al. was 1.9% [41], which is within previously reported range [20,22,43,44]. This differed from the research results of Rod et al., who show a high anastomotic leakage in the LG group (17%) especially in comparison to the OG group (10%). The overall postoperative complications (57% vs 48%; $P = 0.128$) and surgical complications (48% vs 27%; $P = 0.005$) were higher in the LG group compared with the OG group, but postoperative mortality was not influenced [45]. Similarly, Haverkamp et al., reported a 37% complication rate in the LG group [46].

A recent meta-analysis of 15 studies showed that LG was associated with lower intraoperative blood loss (MD, − 76.95 ml; $P < 0.001$), postoperative hospital stay (MD, − 2.84 day; $P < 0.001$), and time to first oral intake (MD, − 0.88 day; $P < 0.001$). On the other hand, LG had a longer operative time and comparable postoperative mortality rate compared with OG [47]. Another meta-analysis of 7 studies showed that LG was associated with lower blood loss (MD, − 127.47; $P = 0.0009$), reduced hospital stay (MD, − 5.26; $P < 0.0001$), shorter time to first oral intake (MD, − 0.94; $P < 0.0001$), time to first flatus (MD, − 1.04; $P < 0.0001$), time to first ambulation (MD, − 2.07; $P < 0.0001$), and longer operative time (MD, 15.73; $P = 0.001$). Regarding overall postoperative complications, surgical complications, medical complications, and pulmonary infections, LG showed favorable results compared with OG. However, in terms of the number of harvested lymph nodes, both groups were comparable ($P = 0.11$) [17].

Li et al. showed that after 4 cycles of neoadjuvant chemotherapy (SOX, CAPOX, or FOLFOX7 regimens), the findings of LG and OG were comparable in terms of distal and proximal margins, number of resected or metastatic lymph nodes, postoperative complications, operation time, blood loss, and length of hospital stay [27]. After 3 years, they published an RCT showing that, among 95 patients with GC who were receiving neoadjuvant chemotherapy before surgery, the LG group had a substantially lower postoperative complication rate than the OG group (20% vs 46%; $P = 0.007$). Moreover, LG was associated with a lower postoperative pain score (visual analog scale) compared with OG (1.5 vs 3; $P = 0.04$) [48]. Wu et al. compared 2 groups of GC patients. The first group received neoadjuvant chemotherapy before the surgery, and the second group was assigned to surgery directly. Total blood loss in a neoadjuvant group was substantially higher compared to that of the other group (320,79 vs 243,37 ml; P < 0,04). However, both groups were comparable regarding operative time ($P = 0.65$), lymph nodes harvested ($P = 0.25$), multiorgan resection ($P = 0.054$), and postoperative complications ($P = 0.361$) [49].

In locally advanced GC, pooling of 5 trials demonstrated that LG with D2 lymphadenectomy had equivalent overall short-term morbidity and mortality compared with OG [18]. On the other hand, Best et al. found no significant difference in short- and long-term results between LG and OG [50]. They disagreed with previous systematic reviews [15,51,52], which concluded that LG is better than OG and they believed that this conclusion was based on weak and heterogeneous studies.

Conclusion

LG for patients with locally advanced GC who have received neo-adjuvant chemotherapy is a safe and feasible alternative to OG. LG showed reduced blood loss, better postoperative healing, and lower postoperative morbidity relative to OG. Nonetheless, well-designed RCTs for further validation are still required. The direct impact of neoadjuvant chemotherapy on LG or OG should be investigated by comparing patients who received neoadjuvant therapy before surgery with those who were assigned to surgery directly.

List Of Abbreviations

GC	Gastric cancer
LG	Laparoscopic gastrectomy
OG	Open gastrectomy
LDG	Laparoscopic distal gastrectomy

Declarations

Ethical approval and consent to participate

All procedures performed in our study involving human participants was approved by the ethical committee of Suez Canal University Hospital (ref # 3374). A written and verbal consent was obtained from all participant in the current study.

Consent for publication

We obtained consent from all the patients included in our study with institutional consent forms.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request. All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

IK, IH & HS carried out and participated in the surgical procedures, **IK, MF & HS** conceived the study, participated in study design and sequence alignment, and drafted the manuscript. **IK,HS & MF** helped to draft and critically revise the manuscript. **IS, MF & HS** participated in data collection and performance of the statistical analysis. **IK, IS & MF** participated in study coordination, and critical revision. All authors have read and approved the final manuscript.

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Figures

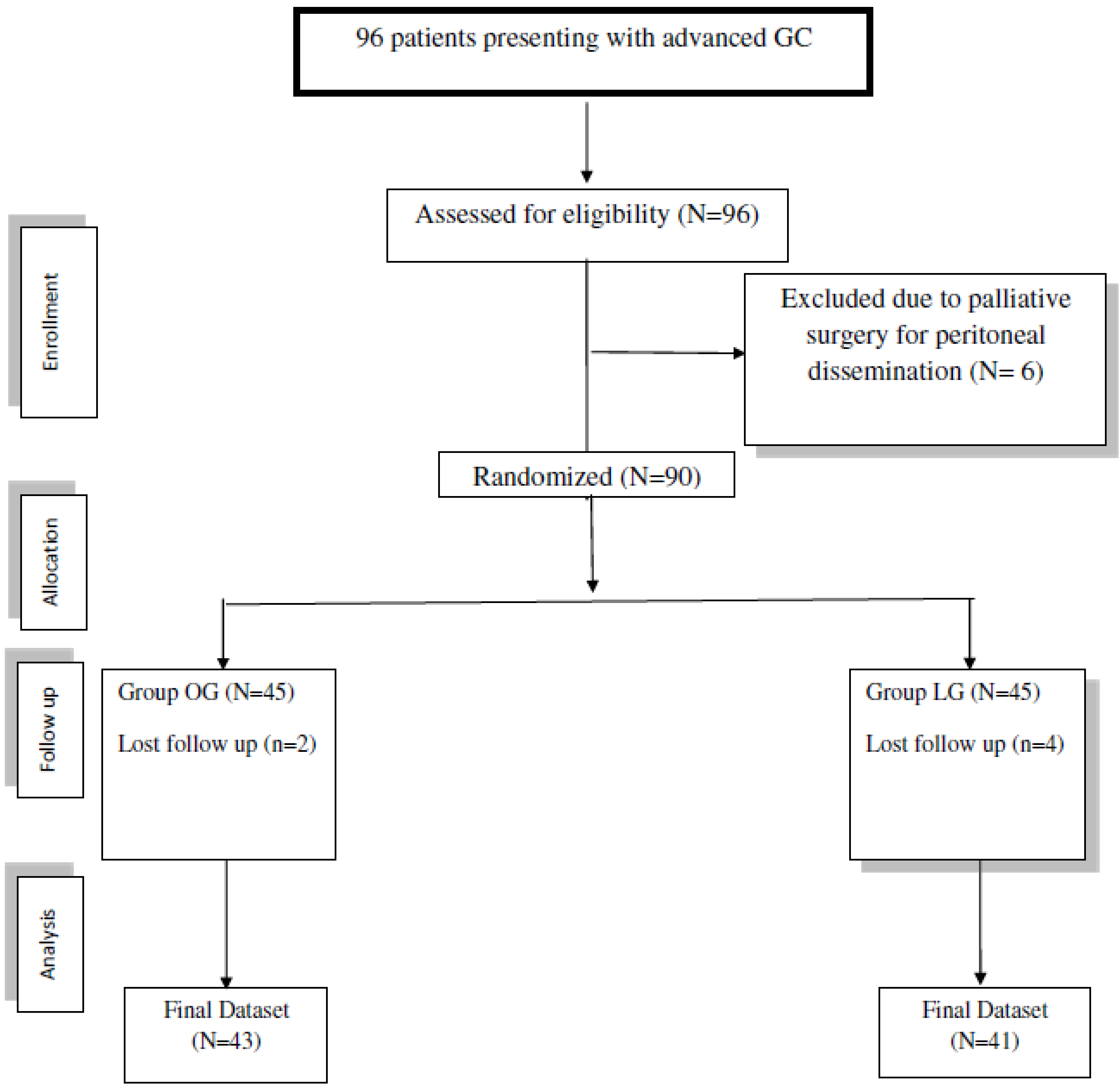

Figure 1

Study flowchart

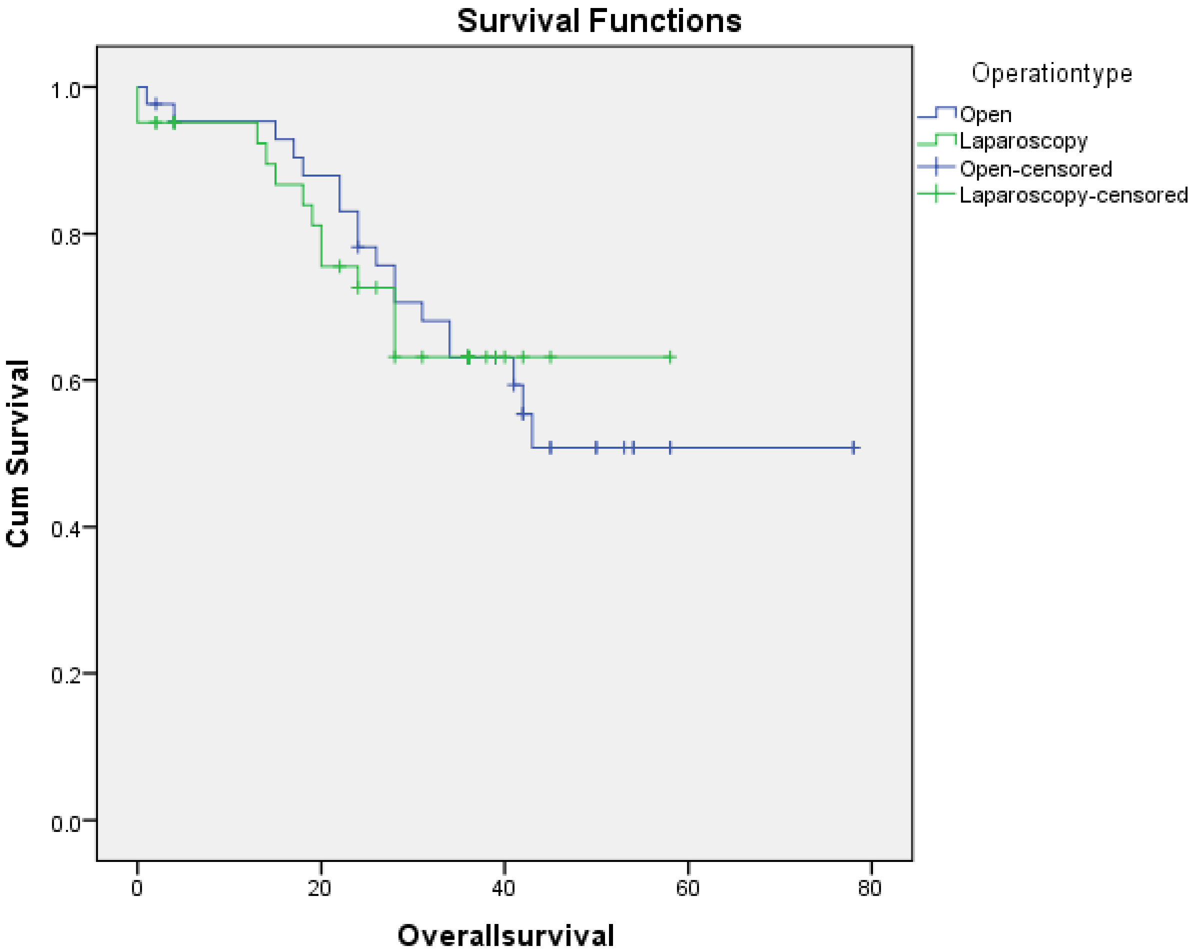

Figure 2

Kaplan−Meier curve showing overall survival

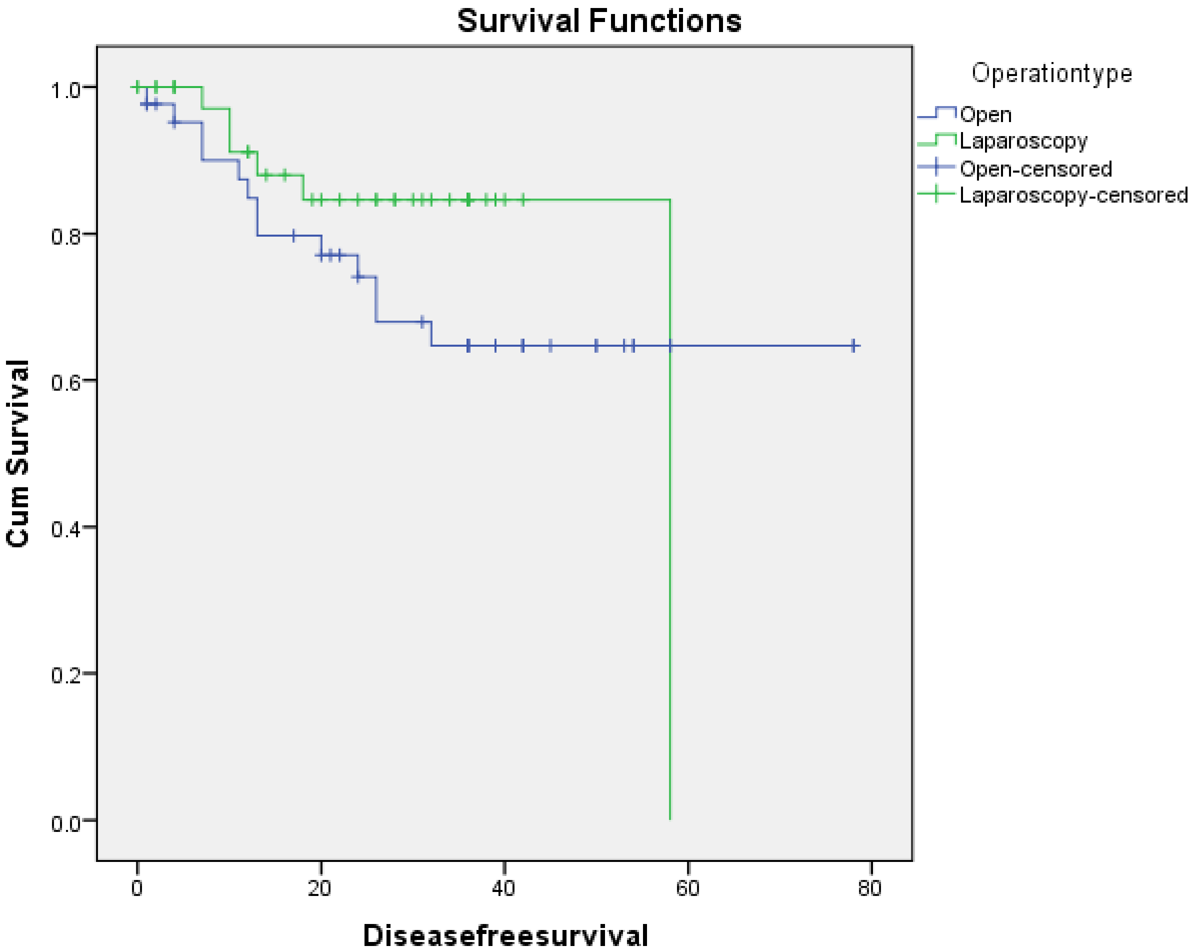

Figure 3

Kaplan–Meier curve showing disease progression-free survival