Long-term oncological outcomes of laparoscopic gastrectomy for grossly early gastric cancer-mimicking advanced gastric cancer

Propensity score matching analysis

Sung Eun Oh, MD, Ji Yeong An, MD, PhD, Min-Gew Choi, MD, PhD, Tae Sung Sohn, MD, PhD, Jae Moon Bae, MD, PhD, Jun Ho Lee, MD, PhD

Abstract
Laparoscopic gastrectomy became an option in the treatment of early gastric cancer (EGC) in clinical practice. However, whether laparoscopic surgery for grossly EGC-mimicking advanced gastric cancer (AGC) patients is oncologically safe long-term is still controversial.

We retrospectively analyzed 472 patients with AGC who were diagnosed as clinical EGC. Patients received laparoscopic or open gastrectomy with standard lymph node (LN) dissection from January 2007 to February 2015. We used a 1:3 propensity score matching method for the analysis. The matching factors were age, sex, body mass index, American Society of Anesthesiologists score and pathologic stage. After the matching process, we evaluated the 5-year overall survival and the cumulative incidence curve of recurrence.

All of the analyzed patients were pathologically diagnosed with AGC after surgery (grossly EGC-mimicking AGC). The median (range) duration of follow-up was 58.0 (0–132) months. After propensity score matching, 31.5% of patients in the laparoscopic group had D1+ LN dissection and 99.2% of patients in the open group had D2 LN dissection. The 5-year overall survival rate between the laparoscopy (n=92) and open groups (n=244) were not significantly different (95.3% versus 91.4%, P=.224). There was no significant difference between the cumulative recurrence incidence curves of the matched groups (P=.319).

Laparoscopic surgery for grossly EGC-mimicking AGC might be safe in terms of long-term survival outcome. After confirming grossly EGC-mimicking AGC in the final pathology report, no additional surgery might be required.

Abbreviations: AGC = advanced gastric cancer, ASA = American Society of Anesthesiologists, BMI = body mass index, EGC = early gastric cancer, LN = lymph node, OS = overall survival.

Keywords: grossly early gastric cancer-mimicking advanced gastric cancer, laparoscopy, recurrence, survival

1. Introduction
The incidence of gastric cancer worldwide is the highest among all cancers[1] and gastric cancer is the most commonly diagnosed cancer in Korea.[2] Many surgical methods have been developed for the treatment of gastric cancer. Laparoscopic gastrectomy for early gastric cancer (EGC) was first introduced in 1994,[3] and several studies have revealed the benefits of minimal invasive surgery when used for gastric cancer, such as less pain after...
surgery, recovery of bowel movements in a short time and fewer hospitalization days after surgery.\textsuperscript{14,5} Based on the long-term results of a randomized clinical trial, laparoscopic assisted distal gastrectomy for EGC has become an alternative to open surgery while maintaining procedural and oncological safety.\textsuperscript{61} Therefore, laparoscopic surgery for EGC is largely accepted and increasingly used in Korea.

As surgeons face multiple laparoscopic cases, they gain more experience and better surgical techniques. With the innovative development of laparoscopic devices, the complicated and difficult procedures of laparoscopic have been mastered. In this regard, the expanded use of laparoscopic surgery for advanced gastric cancer (AGC) has been promising; however, the standard extent of lymph node (LN) dissection of AGC is D2\textsuperscript{7,8} and the long-term oncologic outcome has not been confirmed.

Some patients who are clinically diagnosed with and treated for EGC show a final pathologic report of AGC. These cancers are defined as grossly EGC-mimicking AGCs.\textsuperscript{9} While a randomized clinical trial investigating the long-term survival of patients with AGC who underwent radical laparoscopic surgery is being completed,\textsuperscript{10} we conducted this study to determine whether patients diagnosed with grossly EGC-mimicking AGC need additional surgical intervention regarding LN dissection. We compared the overall survival (OS) and cumulative recurrence incidence between the open surgery group and the laparoscopic group after propensity score matching.

2. Materials and methods

We retrospectively reviewed the medical records of 552 patients who were clinically diagnosed with EGC preoperatively (clinical stage, T1 and AGC postoperatively (pathologic stage, T2 or more). All patients had gastrectomy with LN dissection by laparoscopic or open method at Samsung Medical Center (SMC; Seoul, Korea) from January 2007 to February 2015. Patients who were diagnosed with other malignancies (n = 62) or remnant gastric cancer (n = 18) were excluded from this study. The remaining 472 patients were included in this study and their clinicopathologic data were analyzed. The median (range) follow-up duration of the analyzed patients was 58.0 (0–132) months.

Clinical stage was determined based on results of preoperative esophagogastroduodenoscopy and abdomen-pelvis computed tomography. We evaluated sex, age, body mass index (BMI), reconstruction method, American Society of Anesthesiologists (ASA) score, tumor location, tumor size, histologic differentiation, resection margin (proximal and distal), depth of tumor invasion, LN metastasis, number of dissected LNs, extent of LN dissection (D1+ or D2), lymphatic invasion, vascular invasion, perineural invasion, distant metastasis, pathologic stage and adjuvant chemotherapy. Histologic differentiation was categorized as differentiated or undifferentiated. Well or moderately differentiated adenocarcinoma was classified as differentiated, whereas poorly differentiated tubular adenocarcinoma, signet ring cell, and mucinous adenocarcinoma were sorted to the undifferentiated group. We used the 8th edition American Joint Committee on Cancer classification to classify the pathologic stage. We also evaluated the short-term surgical outcomes and postoperative course, which included operation time (min), estimated blood loss (mL), postoperative complications (recorded according to the Clavien–Dindo classification), and the number of hospitalization days after surgery.

Patients were divided according to the method of surgery, as open surgery or laparoscopy, for analysis. We usually recommended adjuvant chemotherapy except for the patients with stage T2N0 cancers. Follow-up of the enrolled patients was performed via outpatient visits with regular esophagogastroduodenoscopy and computed tomography. Recurrence and survival were confirmed with recent medical records and the National Statistics, Republic of Korea. The study protocol was approved by the institutional review board of SMC (2019-01-100).

2.1. Statistical method

Differences in clinicopathologic parameters between patients who underwent open and laparoscopic surgery were determined by Mann–Whitney test, Wilcoxon rank test, Chi-square test or Fisher exact test. Before and after the matching, the 5-year survival rate was calculated using the Kaplan–Meier method with the log-rank test. The cumulative incidence curve of the recurrence was analyzed with the Fine and Gray model, defining the death event as the competing risk.\textsuperscript{11} Logistic regression was used to check the association between surgical method and survival or recurrence. We matched the 2 study groups in a 1:3 ratio (laparoscopy vs. open surgery) with the caliper of 0.20 of propensity score.\textsuperscript{12} The matching process was executed using R 3.5.1 (Vienna, Austria http://www.R-project.org/), package ‘MatchIt.’ The matching variables were sex, age, BMI, ASA score, and pathologic stage. The hazard ratio and 95% confidence interval were calculated. For univariate analysis of survival, the log-rank test was used. The variables with P < 0.05 in univariate analysis were included for multivariate analysis using the Cox proportional hazards model with the backward logistic regression method to identify independent prognostic factors of survival. P < 0.05 was considered statistically significant. All statistical analysis, except propensity score matching, was carried out using the statistical software SAS version 9.4 (SAS Institute, Cary, NC) and SPSS version 25.0 for Windows (SPSS, Chicago, IL).

3. Results

3.1. Patient demographics and comparison of the laparoscopic and open groups

Among the 472 patients, 97 patients (20.6%) had laparoscopic gastrectomy with LN dissection. In the laparoscopic group, there were significantly more proportions of young (≤ 60 years), female and low BMI (< 23 kg/m\(^2\)) patients than the open group (Table 1). Approximately 61.9% of the laparoscopic group underwent Billroth I anastomosis. Regarding the extent of LN dissection, 33.0% of patients in the laparoscopic group had D1+ dissection and 98.9% of patients in the open group had D2 dissection (P < .001). Although the number of dissected LNs was significantly lower in the laparoscopic group than in the open group (38 ± 12 versus 46 ± 16; P < .001), the pathologic stage including N stage was not significantly different between the 2 groups.

After 1:3 propensity score matching, 92 patients in the laparoscopic group were matched to 244 patients in the open group. The matching factors were age, sex, BMI, ASA score, and pathologic stage, and we confirmed that there were no significant differences in the proportions of the matching factors between the laparoscopic group and the open group (Table 1).
Table 1
Clinicopathologic characteristics of patients in the 2 treatment groups before and after propensity score matching.

| Characteristics | Before matching | After matching (1:3) |
|-----------------|----------------|---------------------|
|                 | Laparoscopy (n = 97) | Open (n = 375) | P value† | Laparoscopy (n = 92) | Open (n = 244) | P value† |
| Age, yr | 50.5 ± 13.4 | 56.1 ± 12.0 | < .001 | 51.5 ± 13.0 | 54.2 ± 11.8 | .042 |
| Age, yr | < .003 | | | | | |
| ≥ 60 | 24 (24.7) | 154 (41.1) | | 24 (26.1) | 84 (34.4) | | | | | |
| < 60 | 73 (75.3) | 221 (58.9) | | 68 (73.9) | 160 (65.6) | | | | | |
| Sex | | | | | | | | | | |
| M | 44 (45.4) | 237 (63.2) | | 44 (47.8) | 129 (52.9) | | | | | |
| F | 53 (54.6) | 138 (36.8) | | 48 (52.2) | 115 (47.1) | | | | | |
| BMI (kg/m²) | 22.4 ± 2.9 | 23.7 ± 3.1 | < .001 | 22.7 ± 2.7 | 22.8 ± 2.7 | .417 |
| BMI (kg/m²) < .001 | | | | | | | | | | |
| ≥ 23 | 36 (37.1) | 216 (57.6) | | 36 (39.1) | 113 (46.3) | | | | | |
| < 23 | 61 (62.9) | 159 (42.4) | | 56 (60.9) | 131 (53.7) | | | | | |
| ASA score | | | | | | | | | | |
| 1 | 51 (52.6) | 177 (47.2) | | 48 (62.2) | 120 (49.2) | .625 |
| 2+ | 46 (47.4) | 198 (52.8) | | 44 (47.8) | 124 (50.8) | | | | | |
| Extent of LN dissection | | | | | | | | | | |
| D1+ | 32 (33.0) | 4 (1.1) | | 29 (31.5) | 2 (0.8) | | | | | |
| D2 | 65 (67.0) | 371 (98.9) | | 63 (68.5) | 242 (99.2) | | | | | |
| Reconstruction | | | | | | | | | | |
| Billroth I | 60 (61.9) | 194 (51.7) | | 57 (62.0) | 123 (50.4) | | | | | |
| Billroth II | 23 (23.7) | 46 (12.3) | | 22 (23.9) | 30 (12.3) | | | | | |
| RY EJ | 14 (14.4) | 135 (36.0) | | 13 (14.1) | 91 (37.3) | | | | | |
| Adjuvant chemotherapy | | | | | | | | | | |
| No | 40 (41.2) | 155 (41.3) | | 38 (41.3) | 102 (41.8) | | | | | |
| Yes | 57 (58.8) | 220 (58.7) | | 54 (58.7) | 142 (58.2) | | | | | |
| Tumor size, cm | 3.7 ± 2.3 | 4.5 ± 2.5 | < .001 | 3.7 ± 2.2 | 4.3 ± 2.6 | < .001 |
| Tumor location | | | | | | | | | | |
| Lower | 56 (57.7) | 151 (40.3) | | 55 (59.8) | 86 (35.2) | | | | | |
| Middle | 34 (35.1) | 123 (32.8) | | 30 (32.6) | 93 (38.1) | | | | | |
| Upper | 7 (7.2) | 91 (24.3) | | 7 (7.6) | 56 (23.0) | | | | | |
| Whole | 0 (0.0) | 10 (2.7) | | 0 (0.0) | 9 (3.7) | | | | | |
| PRM, cm | 4.0 ± 2.8 | 4.0 ± 2.6 | <.001 | 4.1 ± 2.8 | 3.8 ± 3.0 | .287 |
| DRM, cm | 6.1 ± 3.9 | 7.9 ± 4.7 | .001 | 6.2 ± 3.9 | 8.2 ± 4.6 | <.001 |
| Histologic type | | | | | | | | | | |
| Differentiated | 16 (16.5) | 115 (30.7) | | 16 (17.4) | 66 (27.0) | | | | | |
| Undifferentiated | 81 (83.5) | 269 (69.3) | | 76 (82.6) | 178 (73.0) | | | | | |
| Lauren type | | | | | | | | | | |
| Intestinal | 22 (22.7) | 137 (36.5) | | 22 (23.9) | 86 (35.2) | | | | | |
| Diffuse | 59 (60.8) | 177 (47.2) | | 55 (58.7) | 142 (58.2) | | | | | |
| Mixed & Indeterminate | 16 (16.5) | 61 (16.3) | | 15 (16.3) | 31 (12.7) | | | | | |
| Depth of invasion | | | | | | | | | | |
| T2 | 64 (66.0) | 257 (68.5) | | 60 (65.2) | 170 (69.7) | | | | | |
| T3 | 25 (25.8) | 95 (25.3) | | 24 (26.1) | 60 (24.6) | | | | | |
| T4 | 8 (8.2) | 23 (6.1) | | 8 (8.7) | 14 (5.7) | | | | | |
| Dissected LN<sup>5</sup> | 38 ± 12 | 46 ± 16 | <.001 | 38 ± 13 | 47 ± 17 | <.001 |
| LN metastasis | | | | | | | | | | |
| N0 | 56 (57.7) | 202 (53.9) | | 52 (66.5) | 139 (57.0) | | | | | |
| N1 | 20 (20.6) | 89 (23.5) | | 19 (20.7) | 56 (23.0) | | | | | |
| N2 | 18 (18.6) | 47 (12.5) | | 18 (19.0) | 27 (11.1) | | | | | |
| N3a | 3 (3.1) | 26 (6.9) | | 3 (3.3) | 17 (7.0) | | | | | |
| N3b | 0 (0.0) | 12 (3.2) | | 0 (0.0) | 5 (2.0) | | | | | |
| Distant metastasis | 1.000<sup>5</sup> | | | | | | | | | | |
| M0 | 97 (100) | 372 (99.2) | | 92 (100) | 244 (100) | | | | | |
| M1 | 0 (0.0) | 3 (0.8) | | 0 (0.0) | 0 (0.0) | | | | | |
| Pathologic stage<sup>*</sup> | | | | | | | | | | |
| I | 41 (42.3) | 152 (40.5) | | 38 (41.3) | 104 (42.6) | | | | | |
| II | 43 (44.3) | 163 (43.5) | | 41 (44.6) | 106 (43.4) | | | | | |
| III | 13 (13.4) | 57 (15.2) | | 13 (14.1) | 34 (13.9) | | | | | |
| IV | 0 (0.0) | 3 (0.8) | | 0 (0.0) | 0 (0.0) | | | | | |
| Lymphatic invasion | | | | | | | | | | |
| Absent | 58 (59.8) | 184 (49.1) | | 54 (68.7) | 125 (51.2) | | | | | |
| Present | 39 (40.2) | 191 (50.9) | | 38 (31.3) | 119 (48.8) | | | | | |

(continued)

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3.2. Short-term surgical outcomes

The short-term surgical outcomes and postoperative course of the matched patients are shown in Table 2. Operation time did not significantly differ between the study groups ($P = .214$). Estimated blood loss during operation was significantly lower ($P < .001$) and the number of hospital days was significantly lower ($P < .001$) in the laparoscopic group than the open group. The postoperative complication rate between the 2 groups was not significantly different ($P = .387$). In the laparoscopic group, 1 patient underwent emergent operation due to anastomosis site leakage. Two patients in the open group underwent re-operation; 1 patient had wound dehiscence and the other patient experienced immediate postoperative bleeding.

3.3. Long-term surgical outcomes

Before patient matching, there was no significant difference in the 5-year OS between the laparoscopic group and open group (95.5% vs 89.6%; $P = .068$; Fig. 1A). The 5-year cumulative recurrence rate between the 2 unmatched groups was also not significant (laparoscopy versus open, 4.5% versus 8.1%; hazard ratio $= 0.55$, 95% CI $= 0.19$ – 1.59, $P = .272$; Fig. 1B). Similar results were observed in the matched groups. The OS rates between the 2 groups were not significantly different (Fig. 2A, $P = .224$); the 5-year OS was 95.3% in the laparoscopic group and 91.4% in the open group. The association between surgical method (laparoscopy versus open) and death event was not

| Table 2 |
| --- |
| **Short-term surgical outcomes and postoperative course of the matched patients.** |
| **Outcomes** | Laparoscopy (n=92) | Open (n=244) | $P$ value$^*$ |
| --- | --- | --- | --- |
| Operation time (min) | 178 ± 55 | 168 ± 43 | .214 |
| Blood loss during operation (ml) | 135 ± 100 | 170 ± 107 | <.001 |
| Hospital stay (days) | 8 ± 3 | 9 ± 3 | <.001 |
| Postoperative complication (CD classification) | .387$^*$ |
| None | 74 (80.4) | 179 (73.4) |  |
| I | 2 (2.2) | 17 (7.0) |  |
| II | 13 (14.1) | 36 (14.8) |  |
| IIIa | 2 (2.2) | 10 (4.1) |  |
| IIIb | 1 (1.1) | 2 (0.8) |  |

Values in parentheses are percentages. The continuous variables are indicated as mean ± standard deviation.

$^*$ Mann-Whitney test.

CD = Clavien-Dindo.
There were no significant differences in the proportion of the extent of LN dissection after matching (51.5% of patients in the laparoscopic group underwent D1+ dissection and 99.2% of patients in the open group underwent D2 dissection), the multivariate analysis of OS and disease-free survival showed that the surgical method and the extent of LN dissection were not significant independent prognostic factors. In this regard, laparoscopic gastrectomy with D1+ LN dissection in patients diagnosed with grossly EGC-mimicking AGC might be oncologically safe and there will be no need for additional surgery in these patients.

However, when we consider the laparoscopic surgery of the patients with Borrmann type AGC, the extent of LN dissection is our major concern. In terms of the oncologic safety, abundant dissected LNs collected by standard lymphadenectomy can provide a pathological report with accurate evaluation of disease status. A meta-analysis of 16 studies showed that laparoscopic surgery could achieve the same LN dissection effect as open surgery. A large matched cohort study (n = 186) regarding long-term survival in Japan concluded that the oncological outcomes were comparable between the laparoscopic and open surgery groups. In addition, a case-control study conducted in Korea for comparison of the 5-year survival rate and disease-free survival rate showed that there was no significant difference between the laparoscopic and open surgery groups.

In a randomized clinical trial conducted by experienced surgeons at high volume centers in China, the morbidity and mortality rates between the laparoscopy and the open group (n = 528 in each group) were not statistically different. Among the intraoperative effects of the surgical method, the operation time was significantly longer in the laparoscopic group. However, the authors concluded that laparoscopic surgery with extended LN dissection for AGC is a feasible and safe procedure when performed by an experienced surgeon. The operation time of the laparoscopic approach will likely decrease as the surgeons experience more difficult and new cases and overcome the learning curve.

In our study, the operation time was not significantly different between the laparoscopic and open groups. We preferred to perform laparoscopic gastrectomy with D1+ lymphadenectomy for only clinical EGC patients. The operation time might be reduced due to limited LN dissection. We also found that among unmatched patients, female and low BMI patients underwent laparoscopic surgery more often than open method. As female patients have a relatively large portion of subcutaneous fat compared with visceral fat, this phenomenon might reflect the surgeons’ preference of selecting patients for laparoscopic gastrectomy. In fact, the amount of visceral fat requires complex laparoscopic procedures and this might be a barrier for inexperienced surgeons.
| Variables                          | Overall survival | Recurrence-free survival |
|-----------------------------------|------------------|--------------------------|
|                                   | Univariate analysis | Multivariate analysis | Univariate analysis | Multivariate analysis |
|                                   | 5YOS  | P value | HR  | 95% CI | 5YDFS | P value | HR  | 95% CI |
| Method of operation               | .224  | .317    | 95.3| 95.3    | 95.2  | 1.00    | 92.4| 92.4    |
| Laparoscopy                       | 95.3  |         | 95.3|         | 95.2  |         | 92.4|         |
| Open                              | 91.4  |         | 91.3|         | 90.3  | .951    | 93.2|         |
| Age, years                        | .164  |         | 98.0|         | 90.3  |         | 93.2|         |
| ≥ 60                              | 93.8  |         | 93.2|         | 93.2  |         | 93.2|         |
| < 60                              | 98.0  | .729    | 94.1| 95.6    | 95.6  |         | 88.9|         |
| Sex                               | 90.4  | 94.4    | 88.9|         | 94.4  |         | 88.9|         |
| M                                 |       | .729    | 94.1| 95.6    | 95.6  |         | 88.9|         |
| F                                 |       |         | 90.4|         | 88.9  |         | 88.9|         |
| BMI (kg/m²)                       | .287  | .115    | 93.1| 96.6    | 95.6  |         | 89.6|         |
| ≥ 23                              | 91.4  | .729    | 94.4| 95.6    | 95.6  |         | 89.6|         |
| < 23                              | 93.1  | .729    | 94.4| 95.6    | 95.6  |         | 89.6|         |
| ASA score                         | .073  | .631    | 94.5| 95.6    | 95.6  |         | 89.6|         |
| 1                                 | 94.5  |         | 94.5| 95.6    | 95.6  |         | 89.6|         |
| 2                                 | 92.3  |         | 92.3| 95.6    | 95.6  |         | 89.6|         |
| 3+                                | 57.1  |         | 57.1|         | 92.3  | 87.5    | 87.5|         |
| Extent of LN dissection           | .144  | .145    | 100.0|         | 100.0|         | 91.7|         |
| D1+                               | 100.0|         | 100.0|         | 100.0|         | 91.7|         |
| D2                                | 91.7  |         | 91.7|         | 91.7  |         | 91.7|         |
| Reconstruction                    | .007  | .067    | .007| 96.0    | 96.0  |         | 91.9|         |
| Billroth I                        | 98.0  | 1.00    | 98.0| 96.0    | 96.0  |         | 91.9|         |
| Billroth II                       | 86.0  | 3.53    | 122–10.22| 0.200| 88.5  |         | 93.0|         |
| RY EJ                             | 85.2  | 1.93    | 0.75–4.99| 0.175| 87.5  |         | 93.0|         |
| Adjuvant chemotherapy             | .366  | .038    | 95.5| 96.7    | 96.7  |         | 89.8|         |
| No                                | 95.5  |         | 95.5| 96.7    | 96.7  |         | 89.8|         |
| Yes                               | 90.6  |         | 90.6| 96.7    | 96.7  |         | 89.8|         |
| Tumor size, cm                    | .074  | .136    | 88.1| 88.1    | 88.1  |         | 89.8|         |
| ≥ 4                               | 88.1  |         | 88.1| 88.1    | 88.1  |         | 89.8|         |
| < 4                               | 95.7  |         | 95.7| 88.1    | 88.1  |         | 89.8|         |
| Tumor location                    | .096  | .835    | 94.9| 94.2    | 94.2  |         | 89.8|         |
| Lower                             | 94.9  |         | 94.9| 94.2    | 94.2  |         | 89.8|         |
| Middle                            | 94.4  |         | 94.4| 92.5    | 92.5  |         | 89.8|         |
| Upper                             | 88.7  |         | 88.7| 92.5    | 92.5  |         | 89.8|         |
| Whole                             | 42.9  |         | 42.9| 85.7    | 85.7  |         | 89.8|         |
| PRM, cm                           | .326  | .843    | 94.5| 93.6    | 93.6  |         | 89.8|         |
| ≥ 4                               | 94.5  |         | 94.5| 93.6    | 93.6  |         | 89.8|         |
| < 4                               | 91.0  |         | 91.0| 93.6    | 93.6  |         | 89.8|         |
| DRM, cm                           | .780  | .922    | 95.4| 91.9    | 91.9  |         | 89.8|         |
| ≥ 8                               | 95.4  |         | 95.4| 91.9    | 91.9  |         | 89.8|         |
| < 8                               | 90.1  |         | 90.1| 92.5    | 92.5  |         | 89.8|         |
| Histologic type                   | .041  | .867    | 86.1| 92.6    | 92.6  |         | 89.8|         |
| Differentiated                    | 86.1  |         | 86.1| 92.6    | 92.6  |         | 89.8|         |
| Undifferentiated                  | 94.2  |         | 94.2| 92.6    | 92.6  |         | 89.8|         |
| Lauren type                       | .424  | .139    | 88.3| 95.7    | 95.7  |         | 89.8|         |
| Intestinal                       | 88.3  |         | 88.3| 95.7    | 95.7  |         | 89.8|         |
| Diffuse                           | 94.9  |         | 94.9| 92.5    | 92.5  |         | 89.8|         |
| Mixed & Indeterminate             | 91.2  |         | 91.2| 92.5    | 92.5  |         | 89.8|         |
| Depth of invasion                 | <.001 | .003    | 1.00| 95.2    | 95.2  |         | 1.00|         |
| T2                                | 94.7  |         | 94.7|         | 95.2  |         | 1.00|         |
| T3                                | 93.1  | 1.15    | 0.43–3.09| 0.785| 93.0  | 0.88  | 0.30–2.61| .820|
| T4                                | 64.3  | 6.50    | 2.46–17.16| <.001| 59.4  | 5.69  | 1.97–16.45| .001|
| LN metastasis                     | .014  | <.001   | N/A |         | N/A  |         | N/A|         |
| N0                                | 94.1  |         | 94.1|         | N/A  |         | N/A|         |
| N1                                | 94.5  |         | 94.5|         | N/A  |         | N/A|         |
| N2                                | 95.5  |         | 97.1|         | N/A  |         | N/A|         |
| N3a                               | 89.5  |         | 91.0|         | N/A  |         | N/A|         |
| N3b                               | 81.3  |         | 91.0|         | N/A  |         | N/A|         |
| Distant metastasis                | .014  | <.001   | 86.0|         | N/A  |         | N/A|         |
| M0                                | 92.4  |         | 92.4|         | N/A  |         | N/A|         |
| M1                                | 92.4  |         | 92.4|         | N/A  |         | N/A|         |
One of the limitations of this retrospective study is that only a small number of patients were analyzed after propensity score matching. With a small number of patients, we could not further categorize the patients according to specific surgical method such as extra- or intra-corporeal anastomosis, number of trocar insertions, and type of stapler. Due to the very low death and recurrence events in the laparoscopic group, the statistic power was low, and this might have resulted in insignificant differences in the outcome between the 2 groups. In this regard, we performed logistic regression to support the results and found that the outcomes were not significantly correlated with the surgical method.

In conclusion, the laparoscopic method for surgical treatment of patients with grossly EGC-mimicking AGC might be feasible in terms of long-term outcomes. Limited LN dissection (D1+) may be effective without the need for additional surgery after initial curative surgery. However, as grossly EGC-mimicking AGC showed less LN metastasis than AGC, this result needs to be interpreted cautiously when we approach patients with AGCs.

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Author contributions

Jun Ho Lee contributed to the conception of this study and provided critical revision of the study. Sung Eun Oh collected and analyzed the data and drafted the work. Ji Yeong An, Min-Gew Choi, Tae Sung Sohn, and Jae Moon Bae ensured that questions related to the accuracy or integrity of all parts of the work were appropriately investigated and resolved. All authors gave final approval of the version to be published.

Conceptualization: Jun Ho Lee.
Data curation: Sung Eun Oh.
Formal analysis: Sung Eun Oh.
Investigation: Sung Eun Oh, Jun Ho Lee.

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