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Short- and long-term outcomes of robotic-versus laparoscopic-assisted early-onset gastric cancer: a propensity score-matched retrospective cohort study

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Abstract

Background Early-onset gastric cancer (EOGC) is a distinct subtype of gastric cancer with increasing incidence, characterized by unique clinical and pathological features. This propensity score-matched retrospective cohort study aims to compare the perioperative safety and outcomes of EOGC patients who underwent laparoscopic versus robotic radical gastrectomy, providing a scientific basis for surgical treatment of EOGC.

Materials and methods We included 252 patients diagnosed with EOGC at or before the age of 45, who underwent robotic or laparoscopic radical gastrectomy between January 2015 and April 2021. After propensity score matching, 47 patients in the robotic surgery group and 94 in the laparoscopic surgery group were compared. The study evaluated intraoperative and postoperative outcomes, pathological results, and long-term survival.

Results The robotic surgery group showed less intraoperative bleeding (50 ml vs. 100 ml, $p=0.042$) and shorter postoperative hospital stays (6 days vs. 7 days, $p=0.008$) compared to the laparoscopic group. The number of positive lymph nodes was higher in the robotic group (median 2 vs. 1, $p=0.016$), but the number of lymph nodes harvested did not significantly differ. No significant differences were found in overall survival (3-year OS: 65.9% vs. 62.5%, $p=0.596$) and disease-free survival (3-year DFS: 61.4% vs. 61.7%, $p=0.765$) between the two groups.

Conclusions Robotic resection for EOGC is non-inferior to laparoscopic surgery in terms of perioperative outcomes and long-term prognosis. This study suggests that robotic surgery may be a viable option for the treatment of EOGC.

Keywords Early-onset gastric cancer, Robotic surgery, Laparoscopic surgery, Propensity score matching, Perioperative outcomes, Long-term survival

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Introduction

Gastric cancer is one of the most common malignant tumors [1]. In recent years, the overall incidence of gastric cancer has been decreasing [2]. However, early-onset gastric cancer (EOGC), a distinct subtype of gastric cancer, has seen a gradual increase in its incidence, which has attracted considerable attention [3]. EOGC exhibits differences in clinical pathological characteristics, genetic material, microenvironment, and treatment strategies compared to other types of gastric cancer [4–6]. Patients with EOGC are typically younger, and their pathological types are often poorly differentiated adenocarcinomas or undifferentiated carcinomas, which are more prone to distant metastasis, posing significant challenges to treatment [5, 7]. Currently, despite surgery being the primary treatment for EOGC, research on the optimal surgical approach and its safety and efficacy remains insufficient.

Robotic and laparoscopic gastrectomy for radical resection in gastric cancer, as representatives of minimally invasive surgery, have been widely applied in the treatment of gastric cancer [8, 9]. Compared to traditional open surgery, these surgical approaches offer the advantages of reduced trauma and faster recovery, significantly decreasing the incidence of surgical complications and enhancing the quality of life for patients [10]. Particularly for complex and delicate surgical maneuvers, robotic surgery systems have demonstrated unique advantages due to their three-dimensional high-definition vision, flexible manipulative arms, and tremor filtration capabilities [9, 11, 12]. However, despite the initial validation of the safety and efficacy of robotic and laparoscopic surgery in the treatment of gastric cancer, there is a lack of research focusing on EOGC.

Therefore, the aim of this study is to compare the perioperative safety and outcomes of EOGC patients who underwent laparoscopic and robotic radical gastrectomy. By conducting this research, we anticipate providing a more scientific and rational basis for the surgical treatment of EOGC.

Materials and methods

Patients

In this study, EOGC is defined as being diagnosed at or before the age of 45, based on criteria established in previous research [6, 7]. Inclusion criteria for cases: (1). Age ≤ 45 years; (2). Underwent robotic or laparoscopic radical gastrectomy; (3). Postoperative pathological examination confirmed the diagnosis of gastric adenocarcinoma; (4). Pathological stage tumor T1-4a (pT1-4a), N0/ + , M0 at evaluation according to the American Joint Committee on Cancer (AJCC) Cancer Staging Manual Eighth Edition; (5). Complete clinical and pathological data. Exclusion criteria: (1). Concurrent other malignant tumors; (2). Conversion to open surgery or change of surgical procedure during surgery; (3). Preoperative chemoradiotherapy was performed. A total of 252 patients who underwent surgery in the Department of Digestive Surgery at the First Affiliated Hospital of the Air Force Military Medical University between January 2015 and April 2021 were included. Among them, 49 patients underwent robotic surgery, with 26 males and 23 females. The laparoscopic surgery group consisted of 203 patients, with 122 males and 81 females. Further, propensity score matching was used to select patients from both the robotic surgery group and the laparoscopic surgery group as study subjects. This study complies with the Declaration of Helsinki and was conducted in accordance with the protocol approved by the ethics committee of the First Affiliated Hospital of the Air Force Military Medical University, with the ethics protocol number: KY20212211-N-1. Informed consent was obtained from all participants, and they were fully informed about the purpose of the study and the confidentiality of their data.

Surgical procedures and quality control

The surgical approach was determined based on the patient's examination results and intraoperative specifics, categorized into total gastrectomy, distal gastrectomy, and proximal gastrectomy. All surgeries were performed by the same experienced surgical team, with the lead surgeon and assistants having surpassed the learning curve and possessing extensive experience in both robotic and laparoscopic surgery. D2 lymphadenectomy including No. 1, 3, 4sb, 4d, 5, 6, 7, 8a, 9, 11p, and 12a was performed according to the 4th edition of the Japanese Gastric Cancer Treatment Guidelines [13]. Surgical procedures were conducted in accordance with the "Consensus on Robotic Gastric Cancer Surgery (2015 Edition)" and the "Guidelines for Laparoscopic Gastric Cancer Surgery (2016 Edition)". The extent of surgical resection and lymph node dissection was based on the unified standards of the "Japanese Gastric Cancer Treatment Guidelines" and the "Japanese Gastric Cancer Handling Regulations," ensuring the upper and lower surgical margins [13, 14]. A small midline upper abdominal incision (incision length ≤ 7 cm) was used to extract the specimen and perform extracorporeal gastrointestinal reconstruction.

Clinical data collection

Baseline information, perioperative, and pathological information of patients were collected. Baseline data included gender, age, body mass index (BMI), and Nutritional Risk Screening 2002 (NRS2002). Perioperative information included biochemical test results, hospital stay, estimated intraoperative blood loss, operation time, surgical approach, and gastrointestinal reconstruction methods, and postoperative complication status. Pathological examination details included the tumor's location, degree of tumor differentiation, vascular invasion, number of lymph nodes dissected, and TNM staging. Follow-up was conducted through a combination of outpatient visits and telephone follow-ups, with patients receiving regular follow-ups at specified intervals, every three months for the first two years, and then every six months thereafter.

Statistical analysis

Statistical analysis was performed using R (4.2.1). Quantitative data that follow a normal distribution are expressed as the mean ± standard deviation (x ± s), and intergroup comparisons are performed using the independent samples t-test. Quantitative data with a skewed distribution are represented as the median (Q1, Q3), and intergroup comparisons are conducted using the Mann–Whitney U test. Categorical data are presented as absolute numbers and percentages, with intergroup comparisons made using the chi-square test. The Kaplan–Meier method was used with the survival package for proportional hazards assumption testing and survival regression fitting, with results visualized using the survminer package and ggplot2 package. Propensity score matching was performed using a 1:2 nearest neighbor caliper matching method with a caliper value set at 0.02. A p-value < 0.05 was considered statistically significant.

Results

Comparison of baseline data before and after propensity score matching

Out of the 252 patients selected, 143 cases were successfully matched, including 47 in the robotic surgery group and 94 in the laparoscopic surgery group. After propensity score matching, the confounding bias introduced by the NRS2002 factor in the patients was eliminated. The comparison of baseline data, surgical data, and tumor pathology data between the two groups showed no statistically significant differences ($P > 0.05$), providing a more balanced foundation for further comparative analysis (Table 1).

Intraoperative and perioperative outcomes

The robotic surgery group experienced less intraoperative bleeding and shorter postoperative hospital stays. The median (interquartile range [IQR]) intraoperative blood loss in the robotic surgery group was 50 (50, 100)

Table 1 Baseline characteristics

Characteristics	Before matching				After matching			
	Robotic (*N* = 49)	Laparoscopic (*N* = 203)	SMDs	*p*value	Robotic (*N* = 47)	Laparoscopic (*N* = 94)	SMDs	*p*value
Gender, n (%)			0.24	0.369			0.08	0.153
Male	26 (53.1%)	122 (60.1%)			24 (51.1%)	60 (63.8%)		
Female	23 (46.9%)	81 (39.9%)			23 (48.9%)	34 (36.2%)		
Age, year, median (IQR)	40 (36, 43)	40 (36, 43)	0.02	0.646	40 (35.5, 43)	40 (35.75, 43)	0.01	0.698
BMI, kg/m^2, median (IQR)	22.1 (20, 25.4)	22 (20, 25)	0.04	0.768	22.22 (20, 25.4)	22.8 (20, 25.42)	0.03	0.838
NRS2002, n (%)			0.28	0.024			0.06	0.478
< 3	22 (44.9%)	127 (62.6%)			22 (46.8%)	50 (53.2%)		
≥ 3	27 (55.1%)	76 (37.4%)			25 (53.2%)	44 (46.8%)		
Surgical site, n (%)				0.176				0.28
Whole stomach	18 (36.7%)	51 (25.1%)	0.23		18 (38.3%)	24 (25.5%)	0.04	
Distal stomach	28 (57.1%)	144 (70.9%)	0.21		27 (57.4%)	67 (71.3%)	0.03	
Proximal stomach	3 (6.1%)	8 (4.0%)	0.18		2 (4.3%)	3 (3.2%)	0.02	
Differentiation, n (%)				0.381				0.748
Well-differentiated	6 (12.3%)	13 (6.4%)	0.19		4 (8.5%)	11 (11.8%)	0.03	
Moderately differentiated	8 (16.3%)	35 (17.2%)	0.04		8 (17.0%)	13 (13.8%)	0.01	
Poorly differentiated	35 (71.4%)	155 (76.4%)	0.01		35 (74.5%)	70 (74.4%)	0.01	
TNM stage, n (%)				0.1				0.351
I	17 (34.7%)	71 (35.0%)	0.02		15 (31.9%)	38 (40.4%)	0.01	
II	18 (36.7%)	47 (23.2%)	0.23		18 (38.3%)	26 (27.7%)	0.05	
III	14 (28.6%)	85 (41.8%)	0.21		14 (29.8%)	30 (31.9%)	0.04	

SMDs standardized mean differences, *IQR* interquartile range, *BMI* Body mass index, *NRS2002* Nutritional Risk Screening 2002, *TNM* Tumor-Node-Metastasis Staging System ml, compared to 100 (50, 100) ml in the laparoscopic surgery group ($p = 0.042$). The postoperative hospital stay for the robotic surgery group was 6 (6, 7) days, whereas the average stay for the laparoscopic surgery group was 7 (6, 8) days ($p = 0.008$). All other indicators showed no statistically significant differences between the two groups ($P > 0.05$). In the robotic surgery group, there was one case (2.1%) of postoperative anastomotic leakage and one case (2.1%) of intra-abdominal infection. In the laparoscopic surgery group, there were two cases (2.1%) of anastomotic leakage, one case (1.1%) of chylous fistula, one case (1.1%) of intra-abdominal infection, and one case (1.1%) of pulmonary infection. After Clavien-Dindo grading, there was no statistically significant difference in complications between the two groups ($X^2 = 0.493$, $P = 0.920$) Table 2.

Pathologic and oncologic outcomes

The robotic surgery group had a higher number of positive lymph nodes. The median (IQR) number of positive lymph nodes in the robotic surgery group was 2 (0, 8), compared to 1 (0, 2) in the laparoscopic surgery group ($p = 0.016$). Although the robotic group had a higher median (IQR) number of lymph nodes harvested, 23 (19.75, 27), compared to the laparoscopic group's 23 (16, 26), this difference was not statistically significant ($p = 0.225$). There were no statistically significant differences between the two groups in terms of tumor size, Ki67, and perineural/vascular invasion Table 3. The results of the sensitivity analysis further indicate that, the differences in the number of positive lymph nodes between the robotic and laparoscopic groups were not confounded by the type of gastric surgery or tumor location Table S1.

Table 2 Intraoperative and perioperative outcomes

Characteristics	Robotic 47	Laparoscopic 94	Statistic	*p*value
Albumin, g/L, x ± s	43.02 ± 4.364	43.21 ± 4.661	1.432	0.235
Creatinine, μmol/L, x ± s	79.43 ± 21.775	83.02 ± 22.199	0.476	0.491
WBC, 10^9/L, median (IQR)	6.25 (5.19, 8.45)	6.48 (5.02, 8.41)	0.001	0.970
HB, g/L, x ± s	134.21 ± 25.385	137.82 ± 27.515	0.156	0.693
Platelet, 10^9/L, median (IQR)	213.5 (181.25, 285.5)	215 (180.75, 267.75)	-1.642	0.083
D-Dimer, μmol/L, median (IQR)	230 (175, 295)	270 (200, 390)	-1.084	0.278
Operation time, min, x ± s	230.71 ± 40.943	229.5 ± 28.99	0.027	0.869
Blood loss, ml, median (IQR)	50 (50, 100)	100 (50, 100)	-1.982	0.042
Time of first flatus passage, day, x ± s	3.15 ± 0.66	3.21 ± 0.62	- 0.548	0.584
Post-operation hospital stays, d, median (IQR)	6 (6, 7)	7 (6, 8)	-2.635	0.008
Clavien-Dindo grading, n (%)			0.493	0.920
0/I	45(95.8%)	89(94.7%)		
II	0(0%)	1(1.1%)		
III	1(2.1%)	2(2.1%)		
IV	1(2.1%)	2(2.1%)		

IQR interquartile range, *WBC* White Blood Cell, *HB* Hemoglobin

Table 3 Pathologic outcomes

Characteristics	Robotic 47	Laparoscopic 94	Statistic	*p*value
Size, cm, median (IQR)	3 (2, 4)	2.4 (2, 4)	-1.394	0.164
Positive lymph nodes, median (IQR)	2 (0, 4)	1 (0, 2)	-2.418	0.016
Lymph nodes Harvest, median (IQR)	23 (19, 27)	23 (16, 26)	-1.214	0.225
Ki67, %, median (IQR)	60 (50, 70)	60 (45, 70)	-0.34	0.736
Perineural/vascular invasion, n (%)			0.009	0.926
No	18 (38.3%)	36 (37.5%)		
Yes	29 (61.7%)	60 (62.5%)		

IQR interquartile range

Multivariate Cox regression analysis

A multivariate Cox regression analysis was performed to assess the relationships between key prognostic factors and the outcome, adjusting for potential confounders. For lymph nodes harvest, the odds ratio (OR) was 0.775 (95% CI: 0.269—2.228), with a p—value of 0.636, indicating no significant association. For TNM stage, the OR was 1.250 (95% CI: 0.738—2.119) and $p = 0.407$, showing no significant link. The size variable had an OR of 1.164 (95% CI: 0.354—2.106) and a p—value of 0.747, suggesting no significant relationship. Regarding differentiation, the overall p—value was 0.820. Among its categories, well—differentiated had an OR of 0.800 (95% CI: 0.105—6.098, $p = 0.829$), moderately differentiated had an OR of 1.401 (95% CI: 0.306—6.416, $p = 0.664$), and poorly differentiated had an OR of 1.682 (95% CI: 0.953—6.239, $p = 0.450$), none of which were statistically significant Table 4.

Overall survival and disease – free survival

Follow-up was conducted for the patients included in this study, with a duration that spanned from 2 to 91 months and a median follow-up period of 38 months. At the conclusion of the study, neither the robotic nor the laparoscopic group had reached the median follow-up time. During the follow-up period, there were 22 deaths recorded in the robotic surgery group and 43 in the laparoscopic surgery group.

The 3-year cumulative overall survival (OS) rates for the robotic and laparoscopic surgery groups were 65.9% and 62.5%, respectively (hazard ratio [HR]: 0.84; 95% confidence interval [CI]: 0.44–1.60; $p = 0.596$) Fig. 1. Additionally, the 3-year disease-free survival (DFS) rates for the robotic and laparoscopic surgery groups were 61.4% and 61.7%, respectively (HR: 0.92; 95% CI: 0.51–1.63; $p = 0.765$) Fig. 2. The comparison of survival curves did not reveal any statistically significant differences between the two surgical approaches.

Discussion

This study is a comparative cohort study designed to assess the long-term oncological outcomes of robotic versus laparoscopic surgery in patients with EOGC. The impact of confounding factors was minimized through the use of propensity score matching. The results indicated that patients with EOGC who underwent robotic surgery had less intraoperative bleeding, shorter postoperative hospital stays, and a higher number of positive lymph nodes identified. Patients who underwent robotic and laparoscopic-assisted resection for EOGC had similar OS and DFS. The robotic resection for EOGC was non-inferior in terms of perioperative outcomes and long-term prognosis.

Our findings are consistent with multiple large—scale studies comparing robotic and laparoscopic gastrectomy. For example, a multicenter prospective study by Kim et al. involving 434 patients demonstrated comparable perioperative outcomes between robotic and laparoscopic approaches. The operative times and complication rates were similar, corroborating our results regarding the non—inferior safety profiles of the two methods [15]. Similarly, in a multicenter cohort of 3,552 patients, reported that robotic gastrectomy was associated with reduced intraoperative blood loss and more retrieved lymph nodes [16]. Furthermore, a study reinforces these findings, demonstrating that robotic-assisted gastrectomy in Western populations may offer advantages over open or laparoscopic methods, particularly in reducing complications and enhancing recover [17]. We acknowledge that surgeon experience and the learning curve associated with robotic gastrectomy may influence operative efficiency and clinical outcomes, as proficiency in robotic techniques often correlates with reduced operative times and improved postoperative recovery.

In recent years, the increasing incidence of EOGC in major global regions may be linked to a variety of factors, including the advancement of health promotion strategies, heightened awareness of cancer prevention, and the continuous implementation of early detection and

Table 4 Multivariate Cox regression analysis

Characteristics	β	s_x	Wald	OR(95% CI)	*p*value
Lymph nodes harvest	-0.255	0.539	0.224	0.775 (0.269—2.228)	0.636
TNM stage	0.223	0.269	0.689	1.250 (0.738—2.119)	0.407
Size	0.147	0.455	0.104	1.164 (0.354—2.106)	0.747
Differentiation			0.924		0.820
Well-differentiated	-0.224	1.037	0.047	0.800 (0.105—6.098)	0.829
Moderately Differentiated	0.337	0.776	0.189	1.401 (0.306—6.416)	0.664
Poorly differentiated	0.382	0.506	0.571	1.682 (0.953—6.239)	0.450

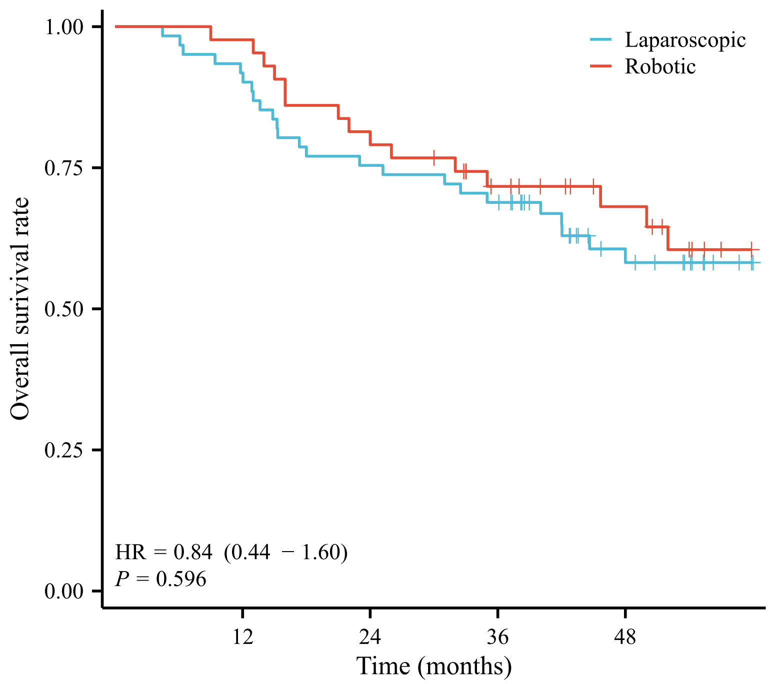

Fig. 1 Overall survival in laparoscopic vs. robotic surgery groups

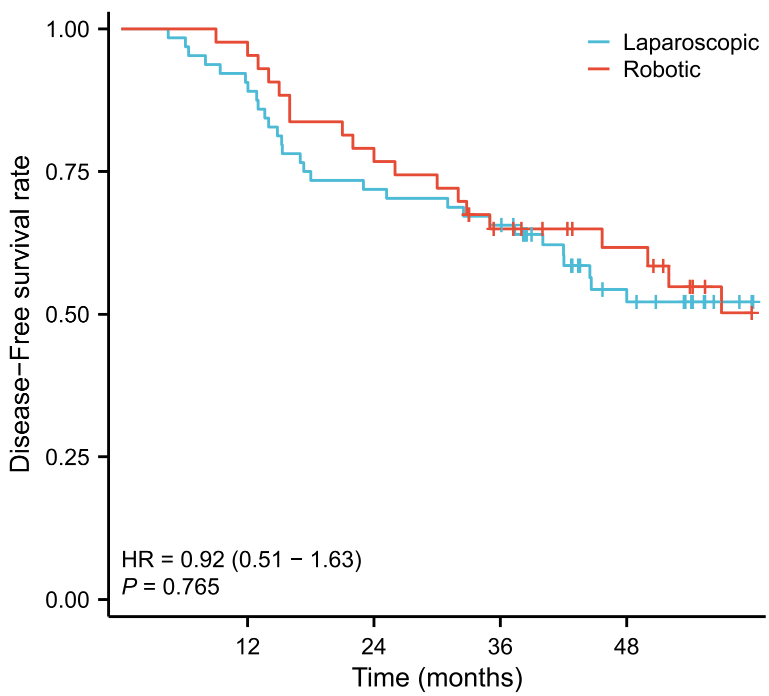

Fig. 2 Disease-free survival in laparoscopic vs. robotic surgery groups

treatment initiatives for tumors [2, 5, 18]. It is projected that by 2035, EOGC will constitute over 30% of the total number of new cancer cases [2, 3]. The malignancy level of EOGC is high, with over 70% of patients in this study presenting with poorly differentiated and advanced-stage gastric cancer, consistent with previous research [6, 18].

The treatment of EOGC should always aim to enhance long-term survival rates, safeguard the quality of life for patients, and facilitate a swift return to social functioning [19]. Although proximal gastrectomy can preserve a portion of the organ, complications such as gastroesophageal reflux disease, delayed gastric emptying, and dysphagia significantly impact the quality of life for patients [20–22]. Consequently, p roximal gastrectomy is not routinely performed in our center except for early-stage patients.

In our analysis of the nutritional status of patients with EOGC utilizing BMI and NRS2002, we observed that patients with EOGC did not exhibit severe malnutrition [23, 24]. These patients are generally younger and have a better performance status, which confers a higher tolerance to perioperative chemotherapy. However, studies have indicated that EOGC patients treated with surgery alone have a better prognosis compared to those who also receive chemotherapy and/or radiotherapy; stratified by stage, tumor size, and histological type, patients receiving combined chemoradiotherapy did not show a survival advantage over those treated with surgery alone or chemotherapy alone [25, 26]. The treatment of EOGC remains limited, and therapeutic strategies need to be more targeted and rational.

Whether in the context of early or advanced gastric cancer, surgery-based comprehensive treatment is a crucial modality for extending patient survival [27]. Minimally invasive surgery (MIS) is deemed safer, more feasible, more aesthetically pleasing, and associated with faster recovery compared to open surgery [28]. The perioperative benefits and oncological safety of MIS have gained widespread recognition [29]. Consequently, laparoscopic radical gastrectomy is now considered the standard surgical approach. However, the maneuverability of laparoscopic instruments remains a limiting factor in D2 lymph node dissection for advanced gastric cancer [30, 31]. In recent years, there has been significant progress in the clinical application of robotic gastrectomy. Robotic surgery effectively addresses the issue of free articulation with linear instruments, overcoming the limitations of traditional laparoscopy, enhancing the precision and flexibility of the surgery [9]. It has been noted that retrieving more positive lymph nodes may reflect improved surgical precision in identifying metastatic nodes or better surgical exposure. However, this did not translate into survival differences, suggesting that while robotic surgery may have advantages in lymph node identification and exposure, these factors do not directly correlate with improved patient survival outcomes [17].

Robotic surgery generally incurs higher costs compared to laparoscopic surgery. This is mainly due to the exorbitant purchase cost of the robotic surgical system. The expenses for surgical consumables are also relatively high [17]. Additionally, there are costs associated with the maintenance of specialized equipment and the training of operating personnel. In the long run, as robotic surgery technology becomes more widespread and the production scale of related equipment and consumables expands, the costs are expected to gradually decline [32].

EOGC is generally of higher malignancy, predominantly characterized by poorly differentiated adenocarcinoma, and associated with advanced TNM staging, consistent with previous research [5]. This scenario increases the complexity of surgery. Due to the enhanced flexibility of robotic surgical instruments and the magnification of the surgical field, the precision of intraoperative dissection is significantly improved compared to laparoscopy. Our study suggest that robotic surgery can reduce intraoperative bleeding and postoperative hospital stay, and can retrieve a greater number of positive lymph nodes [33, 34]. Certain aspects of robotic surgery, such as setup, instrument exchange, and the immobility of instruments when controlling the camera, consume additional time, leading to longer operative times compared to laparoscopic surgery. However, as the proficiency of the surgical team in coordination improves, the operative time for robotic surgery is expected to be further reduced. In this study, the difference in operative time was not statistically significant, a finding that is consistent with other research [35, 36].

Both robotic and laparoscopic surgery have demonstrated excellent safety profiles, with multiple studies reporting an extremely low mortality rate of 0 to 0.2 [15, 16]. In our study, there were no perioperative deaths in either the robotic surgery group or the laparoscopic surgery group. Some studies have included complications graded as Clavien-Dindo II or higher, and the results show that the incidence of postoperative complications in the robotic gastrectomy group is lower than that in the laparoscopic gastrectomy group [8, 37]. Our study found no statistically significant difference in the incidence of systemic complications between the two groups, which may be related to the small sample size. In a comparative analysis of the long-term efficacy between robotic surgery and laparoscopic surgery, no statistically significant differences were observed in terms of OS and DFS.

The present study is not without limitations. Firstly, the present study employed a retrospective design. Despite the fact that Propensity Score Matchin mitigated the influence of confounding factors to a certain degree, it was unable to completely eradicate selection bias. Secondly, given the evolving treatment landscape for gastric cancer, the impact of neoadjuvant therapy on surgical outcomes should be considered. Moving forward, we plan to initiate a prospective, multicenter study to generate higher-grade evidence and determine the most optimal surgical approaches for EOGC.

Conclusions

Robotic resection for EOGC is non-inferior to laparoscopic surgery in terms of perioperative outcomes and long-term prognosis. This study suggests that robotic surgery may be a viable option for the treatment of EOGC.

Abbreviations

EOGC	Early-onset gastric cancer
AJCC	American Joint Committee on Cancer
BMI	Body mass index
NRS2002	Nutritional Risk Screening 2002
TNM	Tumor-Node-Metastasis Staging System
SMDs	Standardized mean differences
IQR	Interquartile range
WBC	White Blood Cell
HB	Hemoglobin
OR	Odds ratio
OS	Overall survival
DFS	Disease-free survival
HR	Hazard ratio
CI	Confidence interval
MIS	Minimally invasive surgery

Supplementary Information

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Supplementary Material 1.

Acknowledgements

Not applicable.

Authors' contributions

J.P.L., J.Z. and Y.L.L.: designed the study; Y.H.Q., B.Y.K., and Y.C.Z.: performed most of the results and completed the manuscript together; J.W.S., S.L., Q.W., and Y.J.G.: helped with following-up and data analysis. All authors read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the First Affiliated Hospital of the Air Force Military Medical University (ethical protocol number: KY20212211-N-1). Informed consent was obtained from all participants, and they were fully informed about the purpose of the study and the confidentiality of their data.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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