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Original Article

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Outcomes of Reduced-Port Robotic Gastrectomy Compared With the Conventional Laparoscopy in Korea (KLASS-13)

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ABSTRACT

Purpose: Radical gastrectomy with lymphadenectomy remains the standard treatment for gastric cancer. Minimally invasive gastrectomy, particularly the reduced-port robotic gastrectomy (REPROG), has gained attention because of its precision and reduced invasiveness. This study aimed to establish a nationwide REPROG database in Korea and to evaluate its clinical outcomes.
Materials and Methods: All patients who underwent REPROG between February 2014 and December 2023 were analyzed. A comprehensive analysis of these patients, including perioperative outcomes, was conducted. To compare outcomes, a control group was selected from the 2019 Korea Nationwide Gastrectomy Database, focusing on patients receiving multiport conventional laparoscopic gastrectomy (CLG). A 1:2 propensity score matching was performed based on patient, tumor, and surgical characteristics. Perioperative outcomes, including the length of hospital stay, were compared between the matched cohorts.
Results: A total of 1,071 patients who underwent REPROG were collected, of which 1,060 were included after exclusion and compared with CLG cases from a nationwide database. REPROG demonstrated a significant reduction in hospital stay, with a mean duration of 6.1 days compared with 7.8 days for the CLG (P<0.001). The incidence of major complications was similar between the 2 groups (1.9% vs. 2.4%, P=0.493). The conversion rate for REPROG was 0.19%. The annual number of patients receiving REPROG steadily increased, reaching 267 patients (24.9%) by 2023.
Conclusions: Patients undergoing REPROG had a shorter hospital stay and a low conversion rate, indicating its potential as a treatment option for gastric cancer when performed by highly experienced surgeons.

Keywords: Gastric neoplasms; Robotic surgical procedures; Gastrectomy

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Presentation
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Conflict of Interest
Hyoung-Il Kim received a research grant from the Intuitive Surgery Department, Inc. No other disclosures are reported.

Author Contributions
Conceptualization: P.S.H., K.H.I.; Data curation: P.S.H., A.S.H., L.C.M., L.H.H., S.Y.S., K.Y.M., P.Y.S.; Formal analysis: P.S.H., K.E.H.; Funding acquisition: K.H.I.; Investigation: P.S.H., A.S.H., L.C.M., L.H.H., S.Y.S.; Methodology: K.Y.M., P.Y.S., K.H.I.; Project administration: K.H.I.; Resources: K.H.I.; Software: P.S.H., K.E.H; Supervision: A.S.H., L.C.M., L.H.H.; Validation: S.Y.S., K.Y.M., P.Y.S.; Visualization: P.S.H.; Writing - original draft: P.S.H.; Writing - review & editing: K.H.I.

INTRODUCTION

Gastric cancer (GC) is the fifth most common malignancy and the fifth leading cause of cancer-related mortality worldwide [1-3]. Radical gastrectomy with adequate lymphadenectomy remains the most effective treatment for complete tumor removal and a potential cure [4-6]. According to the Korean Practice Guidelines for Gastric Cancer, robotic gastrectomy is an appropriate option for gastrectomy, including locally advanced disease, because of its potential advantages, such as high-resolution three-dimensional imaging and wrist anti-tremor action, which enhance surgical precision and lymphadenectomy quality [7-10].

Since its introduction, robotic gastrectomy has been widely adopted and has gained popularity owing to its potential for non-inferior long-term outcomes and the possibility of a lower complication rate than conventional laparoscopic surgery [11-13]. Furthermore, reduced-port gastrectomy using a robotic system has been performed with the expectation of potential benefits associated with minimizing the number of ports, such as reduced postoperative pain, improved cosmetic outcomes, and a lower risk of port-related complications [14-19]. The earlier da Vinci Si and Xi systems (Intuitive Surgical Inc., Sunnyvale, CA, USA) enabled reduced-port surgery through their single-site platform, allowing surgeons to perform procedures with fewer trocars while maintaining robotic precision [17,18]. Expanding on these innovations, the da Vinci SP system was recently introduced and was specifically designed to optimize procedures requiring fewer trocars, including single-port surgery [19,20].

South Korea has a high prevalence of gastric cancer and has established an effective nationwide early detection screening program [6,21]. Consequently, gastric cancer surgery is widely performed. To share knowledge and discuss advancements in the surgical treatment of gastric cancer, Korean surgeons have formed the Korean Laparoendoscopic Gastrointestinal Surgery Study Group (KLASS), which conducts collaborative research and investigates various surgical approaches [22]. Although reduced-port robotic gastrectomy (REPROG) is increasingly performed, the overall case volume and clinical adoption have not been systematically analyzed. As part of KLASS's research initiative, this study aimed to establish a database of REPROG cases to assess their feasibility and outcomes (KLASS-13).

MATERIALS AND METHODS

Data collection

Nationwide REPROG registry

Under the Korean Gastric Cancer Association (KGCA), the KLASS initiated a REPROG registry in May 2023. As part of the KLASS research, we recruited surgeons with experience in at least one REPROG case and collected data from various institutions. REPROG was defined as a procedure using three or fewer trocars, and cases were collected regardless of the robotic surgical system used [23]. We retrospectively collected the data of all patients from the surgeon's first REPROG until December 2023. Data on REPROG performed by nine surgeons from four institutions were collected. Details of the surgical method, including robotic system type, incision location, and number of trocars, varied according to the surgeons. **Fig. 1** shows a schematic representation of the surgical methods used in this study. Variables from the case report form of the KGCA nationwide survey were included

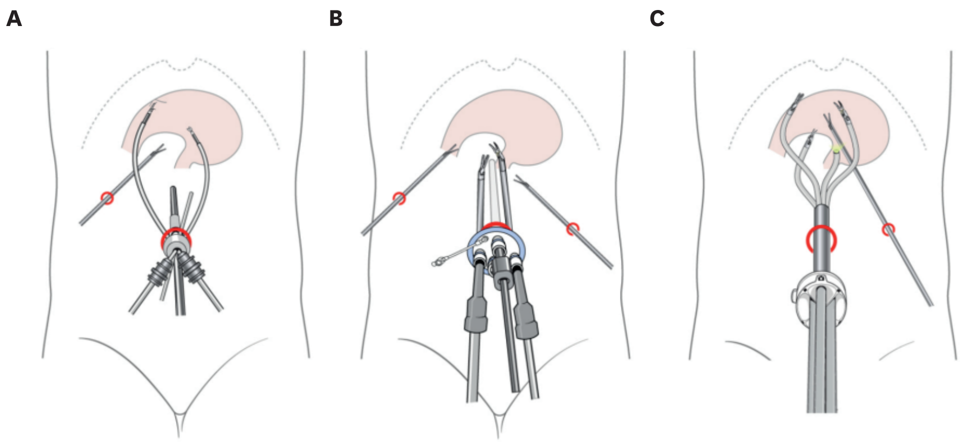

Fig. 1. Detailed schematic illustration of the REPROG method. (A) Two-port REPROG using the Single-Site system of the DaVinci Si or Xi, (B) Three-port REPROG using the glove port with the DaVinci Si or Xi, and (C) Two-port REPROG using DaVinci SP.
REPROG = reduced-port robotic gastrectomy.

along with additional variables related to reduced-port robotic surgery (**Supplementary Table 1**) [24]. This study was approved by the Institutional Review Board of Severance Hospital, Yonsei University Health System (4-2023-0846). The requirement for informed consent was waived due to the retrospective nature of the study.

The 2019 Korea nationwide gastrectomy survey (control group)
The Information Committee of the KGCA developed a case report form for a nationwide survey. The case report forms comprised 54 variables collected by each institution, and were thoroughly reviewed by the Information Committee to address any missing data [24,25]. The variables were designed to comprehensively cover not only patient and tumor characteristics, but also factors involved in the treatment process, including pre- and post-treatment clinical staging, histological staging, surgical interventions, and follow-up processes [26-29]. The clinicopathological staging of gastric cancer was based on the 8th edition of the American Joint Committee on Cancer (AJCC) staging system [30]. Using the collected 2019 nationwide survey data, the KGCA invited research proposals and distributed nationwide survey data to the approved researchers. This study used 2019 nationwide survey data to compare REPROG with conventional laparoscopic gastrectomy (CLG). Before conducting the main comparative analysis, to minimize the potential bias arising from the discrepancy in study periods between the REPROG (2014–2023) and CLG (2019) groups, we first conducted a subgroup analysis within the REPROG cohort, comparing cases performed in 2019 with those from other years (2014–2018 and 2020–2023) (**Supplementary Table 2**).

Statistical analysis

Statistical analyses were performed using R (version 4.4.3; R Foundation for Statistical Computing, Vienna, Austria). Prior to propensity score matching (PSM), comparisons between groups were conducted using Student's t-test or Mann-Whitney U test for continuous variables and χ^2 or Fisher's exact test for categorical variables. Following PSM, the matched data were analyzed using linear mixed models for continuous variables and generalized estimating equations for categorical variables to account for matched structures. The balance of covariates before and after PSM was evaluated using absolute

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standardized differences, with values less than 0.1 considered indicative of adequate balance. PSM was performed using the 'MatchIt' package in R to minimize selection bias in the clinicopathological features when comparing patients undergoing REPROG to patients undergoing CLG from the 2019 nationwide survey data. In detail, a caliper width of 0.1 was applied, corresponding to 0.2 times the standard deviation of the logit of the propensity scores. Furthermore, the discard option was configured to 'both' to ensure balanced comparisons between groups for 1:2 matching using the nearest method, adjusting for the following factors: patient demographics (age, sex, body mass index, American Society of Anesthesiology score, and abdominal operation history), surgical extent (resection extent and lymph node dissection extent), and tumor size. All statistical tests were two-sided, and P-values <0.05 were considered significant.

RESULTS

Collection of the REPROG database

A retrospective review identified 1,071 patients who underwent REPROG performed by nine surgeons across four institutions between February 2014 and December (**Fig. 2**). Among the 1,071 patients, after excluding six patients with stage IV cancer, 2 undergoing non-curative R1 or R2 resections, and three with incomplete clinicopathological data, the study group ultimately included 1,060 patients. During 2022 and 2023, 37.9% of the procedures (406/1,071) were performed, with 24.9% of the total (267/1,071) being performed in 2023 (**Fig. 3**).

The basic characteristics of the 1,060 analyzed patients undergoing REPROG are presented in **Table 1**. The mean (standard deviation) age of the patients was 56.5±11.4 years, and 593 patients (55.9%) were male. Additionally, 15.4% of the patients had an American Society of Anesthesiologists score of 3 or 4, and 24.5% had a history of abdominal surgery.

Table 1. Demographics, tumor characteristics, and surgical features in the multicenter database of patients undergoing REPROG

Characteristics	REPROG (n=1,060)
Age (yr)	56.5±11.4
Sex	
Male	593 (55.9)
Female	467 (44.1)
BMI (kg/m²)	24.0±3.3
ASA score	
1, 2	897 (84.6)
3, 4	163 (15.4)
Abdominal operation history	
Yes	260 (24.5)
No	800 (75.5)
Resection	
Distal gastrectomy	820 (77.4)
Proximal gastrectomy	64 (6.0)
Pylorus preserving gastrectomy	84 (7.9)
Total gastrectomy	81 (7.6)
Other	11 (1.0)
Dissection	
D1+	820 (77.4)
D2	240 (22.6)

Values are presented as mean ± standard deviation or number (%).
REPROG = reduced-port robotic gastrectomy; BMI = body mass index; ASA = American Society of Anesthesiologists.

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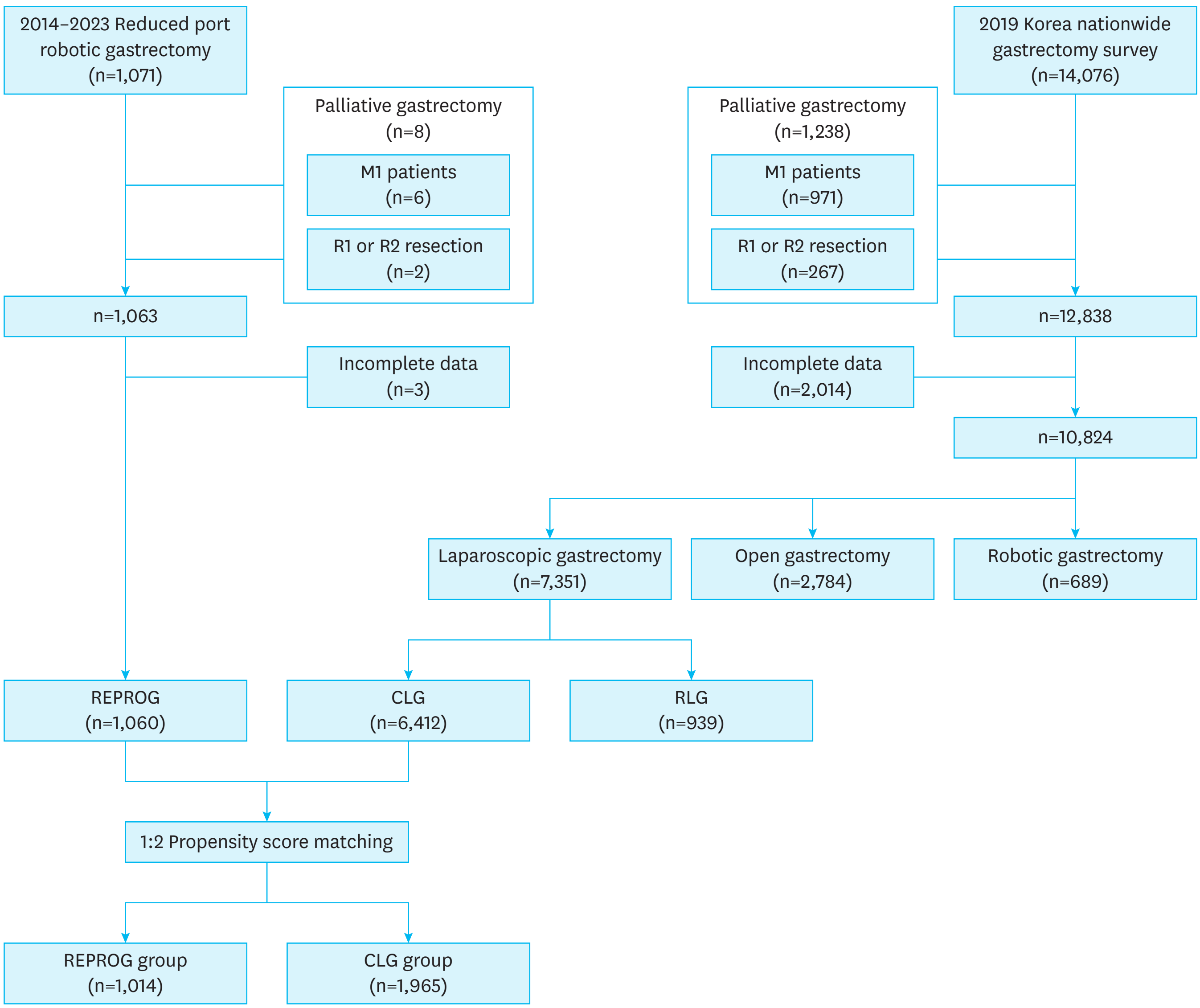

Fig. 2. Study flow diagram.
REPROG = reduced-port robotic gastrectomy; CLG = conventional laparoscopic gastrectomy; RLG = reduced port laparoscopic gastrectomy.

In addition to distal gastrectomy, various extents of resection were performed, including D2 lymph node dissection in 22.6% of patients. Of these, only two patients were converted to open or laparoscopic methods, resulting in a conversion rate of approximately 0.19%. All other procedures were completed as reduced-port procedures using three or fewer surgical access ports.

Perioperative outcome

Table 2 summarizes the outcomes of REPROG in 1,060 patients. The mean operative time was 195.4±62.9 minutes, with an estimated blood loss of 48.4±86.6 mL. Although the timing of oral intake varied by postoperative protocol, patients typically began taking sips of water at a mean period of 1.4 days (median, 1 days; interquartile range [IQR], 1–2 days) and advanced to a soft diet at a mean period of 2.9 days (median, 2 days; IQR, 2–4 days). The mean postoperative period to the first flatus was 3.0 days (median, 3 days;

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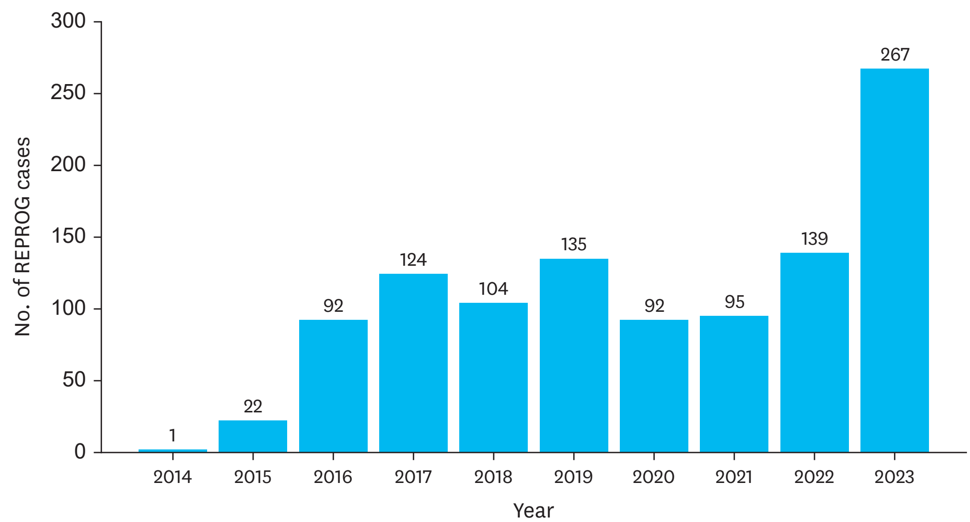

Fig. 3. Annual numbers of REPROG procedures between 2014 and 2023.
REPROG = reduced-port robotic gastrectomy.

Table 2. Postoperative outcomes in the multicenter database of patients undergoing REPROG

Characteristics	REPROG (n=1,060)
Operation time (min)	195.4±62.9
Bleeding amount (mL)	48.4±86.6
Conversion to laparoscopy or open	
Yes	2 (0.2)
No	1058 (99.8)
Tumor size (mm)	2.8±1.9
Number of retrieved LNs	45.7±18.1
Number of metastatic LNs	0.7±3.2
Stage (AJCC 8th)	
I	901 (85.0)
II	100 (9.4)
III	59 (5.6)
Diet buildup (days)	
Sips of water	1 [1–2]
Soft diet	2 [2–4]
Gas passing	3 [2–3]
Length of hospital stay (days)	6.1±3.9
Length of hospital stay (days)	5 [4–6]
Complications*	
No	670 (63.2)
Grade I	193 (18.2)
Grade II	177 (16.7)
Grade III	20 (1.9)
Grade IV or higher	0 (0.0)

Values are presented as mean ± standard deviation, number (%), or median [interquartile range].
REPROG = reduced-port robotic gastrectomy; LN = lymph node; AJCC 8th = American Joint Committee on Cancer Staging, 8th edition.
*Thirty-day complication or readmission rates according to the Clavien-Dindo classification system.

range, 2–3 days). The mean postoperative hospital stay was 6.1 days (median, 5 days; range, 4–6 days). There were no mortalities or complications above grade IVa, and the rate of major complications, classified as grade III or higher according to the Clavien–Dindo classification, was 1.9% (20/1,060) within the first 30 days after REPROG.

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Comparison with 2019 Korea nationwide gastrectomy survey data

The KGCA conducted a nationwide gastrectomy survey that collected gastrectomy data from 68 hospitals in 2019, which included 14,076 patients. Applying the same exclusion criteria to the nationwide gastrectomy database, 1,238 patients who underwent palliative gastrectomy were excluded, along with an additional 2,014 patients owing to insufficient data for comparative analysis (**Fig. 2**). The comparative analysis designated the CLG group as the control group for REPROG and identified 6,412 patients as part of the control group. A comparison of the perioperative clinicopathological features of the two groups revealed significant age differences (56.5 vs. 62.9 years, $P<0.001$), sex ($P<0.001$), body mass index ($P=0.003$), abdominal operation history ($P<0.001$), resection extent ($P<0.001$), lymphadenectomy extent ($P<0.001$), and tumor size ($P<0.001$) (**Supplementary Table 3**).

After a 1:2 PSM, 1,014 patients from the REPROG group and 1,965 from the CLG group were included in the final analysis. The groups were well-balanced in terms of preoperative tumor characteristics, extent of resection and lymphadenectomy, and tumor size (**Table 3**). A comparison of the postoperative hospital stays revealed that the REPROG group had

Table 3. Clinicopathologic features and surgical outcomes of patients undergoing REPROG and multiport CLG after propensity score matching

Variable	1:2 Propensity score-matched groups		P-value	ASD
	REPROG (n=1,014)	CLG (n=1,965)		
Age* (yr)	56.7±11.4	57.0±11.8	0.641	0.009
Sex*			0.276	0.017
Male	580 (57.2)	1,165 (59.3)		
Female	434 (42.8)	800 (40.7)		
BMI* (kg/m²)	24.0±3.3	24.1±3.3	0.815	0.006
ASA score*			0.330	0.015
1, 2	853 (84.1)	1,626 (82.7)		
3, 4	161 (15.9)	339 (17.3)		
Abdominal operation history*			0.798	0.008
Yes	242 (23.9)	477 (24.3)		
No	772 (76.1)	1488 (75.7)		
Resection*			0.078	0.108
DG	819 (80.8)	1,624 (82.6)		
PG	64 (6.3)	115 (5.9)		
PPG	39 (3.8)	41 (2.1)		
TG	81 (8.0)	166 (8.4)		
Other	11 (1.1)	19 (1.0)		
Dissection*			0.924	0.001
D1+	774 (76.3)	1,487 (75.7)		
D2	240 (23.7)	478 (24.3)		
Operative time (min)	196.3±63.0	182.7±62.2	<0.001	0.208
Tumor size* (mm)	2.8±1.9	2.9±2.0	0.549	0.017
Number of retrieved LNs	45.5±18.2	39.5±16.8	<0.001	0.344
Number of metastatic LNs	0.8±3.3	0.7±3.0	0.477	0.031
Stage (AJCC 8th)			0.296	0.058
I	859 (84.7)	1,689 (86.0)		
II	96 (9.5)	187 (9.5)		
III	59 (5.8)	89 (4.5)		
Length of hospital stay (days)	6.1 (4.0)	7.8 (4.7)	<0.001	0.417
Grade III or higher complications†			0.424	0.005
No	994 (98.0)	1,917 (97.6)		
Yes	20 (2.0)	48 (2.4)		

Values are presented as mean ± standard deviation or number (%).
REPROG = reduced-port robotic gastrectomy; CLG = conventional laparoscopic gastrectomy; ASD = absolute standardized difference; BMI = body mass index; ASA = American Society of Anesthesiologists; DG = distal gastrectomy; PG = proximal gastrectomy; PPG = pylorus-preserving gastrectomy; TG = total gastrectomy; LN = lymph node; AJCC 8th, American Joint Committee on Cancer Staging, 8th edition.
*Matched variables.
†Thirty-day complication or readmission rates according to the Clavien-Dindo classification system.

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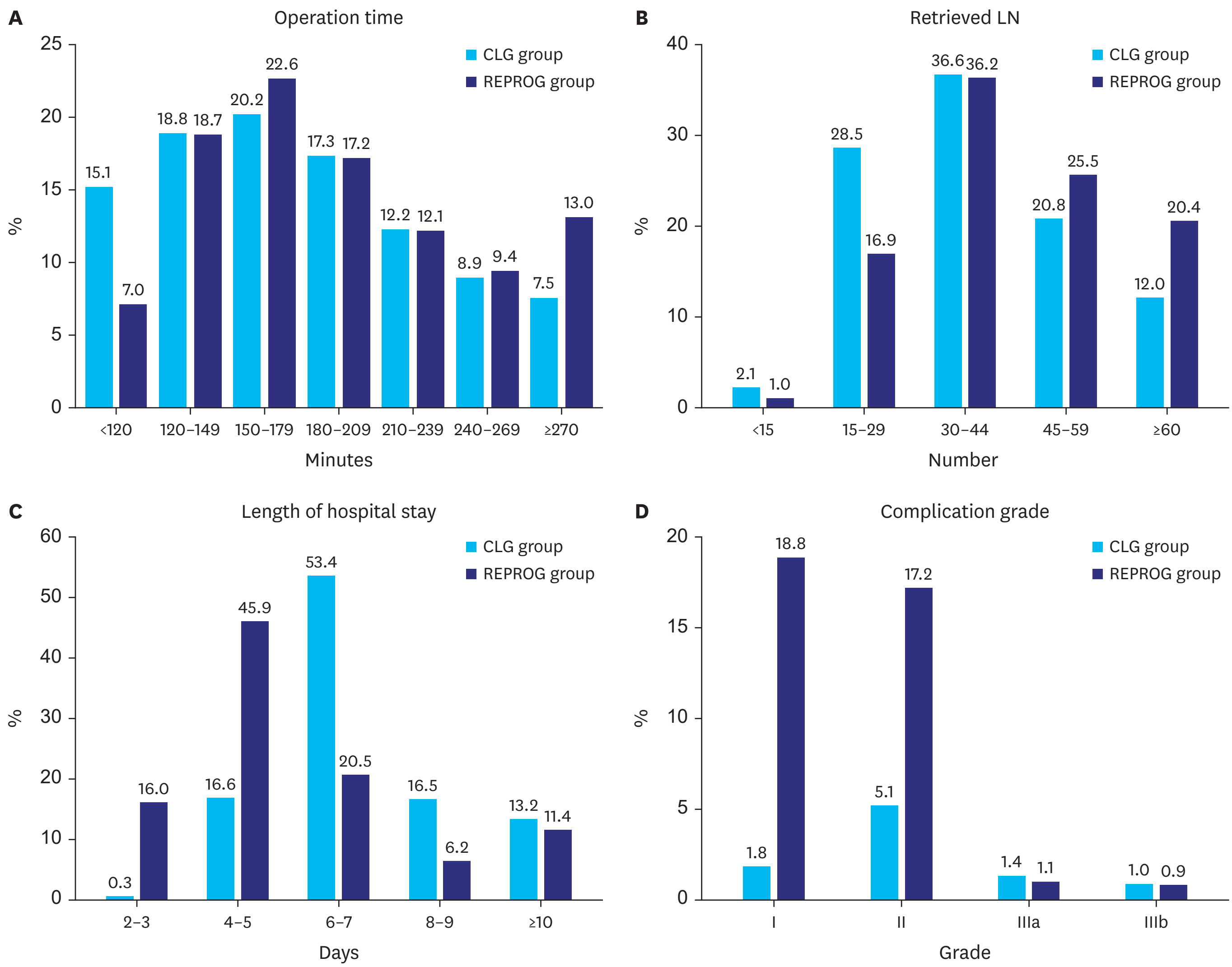

Fig. 4. Comparison of perioperative outcomes between the REPROG and multiport CLG groups after propensity score matching. (A) Operative time, (B) number of retrieved lymph nodes, (C) length of hospital stay, and (D) complications.
REPROG = reduced-port robotic gastrectomy; CLG = conventional laparoscopic gastrectomy.

significantly shorter hospital stays (6.1 vs. 7.8 days, P<0.001) (**Fig. 4**). Additionally, the rate of major complications within 30 days postoperatively, classified as grade III or higher according to the Clavien-Dindo classification, was comparable between the groups (2.0% vs. 2.4%, P=0.424). The conversion rate was not available in the 2019 nationwide gastrectomy survey database, which included the CLG group.

DISCUSSION

In this study, a database of patients undergoing REPROG performed across multiple institutions in Korea was collected and clinical outcomes were retrospectively assessed relative to those of conventional multiport laparoscopic gastrectomy. A total of 1,071 REPROG procedures performed between 2014 and 2023 were included in the database. Following the introduction of the da Vinci SP system, the case volume showed an annually increasing pattern, with 267 cases (24.9%) expected to be performed by 2023. The analysis indicated that REPROG was associated with a significantly shorter hospital stay, while maintaining a comparable rate of major complications. Only 2 patients required conversion, resulting in a conversion rate of 0.19%. In this study, the conversion rate of the control group was not available from the nationwide survey. However, given that the known rate for laparoscopic gastrectomy in Korea is up to 0.9%, a conversion rate of 0.19% is considered acceptable [31-34].

Since the introduction of minimally invasive surgery, surgeons have made extensive efforts to demonstrate that safe and adequate quality surgery can be achieved with fewer trocars and incisions. Reducing the number of access ports during gastrectomies may minimize surgical trauma [35-37]. With fewer incisions, postoperative pain may be reduced, potentially leading to faster recovery and earlier return to daily activities [38,39]. Furthermore, smaller incisions may improve cosmetic outcomes, which may be particularly relevant in patients with postsurgical scarring [17,19]. Furthermore, the lower risk of port-related complications such as trocar site hernias and wound infections is another possible advantage. Reduced-port surgery remains a technical challenge that surgeons continue to optimize.

Despite the advantages of reduced-port gastrectomy, laparoscopic reduced-port surgery remains technically demanding due to instrumental articulation limitations. Robotic systems address these challenges by providing superior visualization, wristed instruments, and tremor filtration. With the adoption of robotic systems, the reduced-port approach has become more feasible, especially with the introduction of the da Vinci Single-Site and SP systems [18-20,40]. The robotic system enables gastrectomy with a reduced number of trocars by integrating robotic advantages into a minimal trocar approach. Thus, robotic systems offer a significant potential for optimizing reduced-port approaches in gastric cancer surgery.

This study collected and analyzed nearly all patients undergoing REPROG in South Korea, reflecting the growing adoption of this technique. Since the first procedure was performed in 2014, data from 10 years have been compiled, and an annual increase in the number of procedures has been observed. Despite a decrease in cancer screening due to the COVID-19 pandemic since 2020, the number of patients receiving REPROG gradually increased following the introduction of the DaVinci SP [41]. Notably, 37.9% of the total cases (406/1,071) were performed in the last two years. In 2019, REPROG accounted for 1% of all gastrectomies performed in South Korea (146/14,076) (**Fig. 2**).

The development of new instruments and emergence of new technologies have helped address the technical challenges traditionally associated with reduced-port surgery. Without these challenges, the potential benefits of fewer trocars, such as minimizing surgical trauma, accelerating recovery, and enhancing cosmetic outcomes, are increasingly being realized, contributing to their growing popularity and establishment as viable treatment options. Therefore, REPROG showed a shorter hospital stay and an acceptable major complication rate when compared with that of CLG. Although our findings showed a reduction in hospital stay, the clinical relevance may be limited without data on pain, satisfaction, or cost. However, previous single-center data have suggested potential benefits in these areas [17].

With continued advancements in reduced-port procedures that reduce technical difficulty, REPROG has the potential to be more widely considered. As surgical tools and devices

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Journal of Gastric Cancer

continue to develop, these improvements may support ongoing progress in the field. Although currently performed primarily at high-volume centers, REPROG may gradually see broader adoption with increasing clinical experience, as is the case with laparoscopic gastrectomy.

To the best of our knowledge, this study is the first comprehensive analysis of REPROG. However, this study has several limitations. First, the retrospective design introduced an inherent selection bias, which could have affected the outcomes and comparisons between REPROG and CLG. Additionally, the control group was based on data from the 2019 nationwide gastrectomy survey, whereas the REPROG group spanned multiple years, potentially introducing temporal differences in surgical practices and patient characteristics. Additionally, the REPROG group data encompassed the initial procedures of the nine surgeons to all subsequent procedures, indicating that this dataset included procedures performed by surgeons at the beginning of the learning curve. However, REPROG was performed by a limited number of surgeons and institutions, which may limit the applicability of these findings, as the results may not fully reflect outcomes from centers with less experience in robotic surgery.

It should also be noted that although a comparison with non-robotic reduced-port laparoscopic gastrectomy might better highlight the specific advantages of REPROG, we selected CLG as the comparator because of its broader clinical adoption and relevance. Furthermore, this study was constrained by variables available in the nationwide survey, meaning that early recovery factors such as postoperative pain, time to first flatus, and conversion rate could not be analyzed. Additionally, the quality of reporting grade II or lower complications differed between the 2 databases. Finally, the long-term outcomes, which are essential for evaluating the sustainability and long-term outcomes of the procedure, were not analyzed. Recent single-center evidence suggests that the long-term oncologic outcomes of REPROG may be comparable with those of CLG, supporting the need for further prospective studies to confirm these findings [42].

In conclusion, this study is the first comprehensive analysis of REPROG and provides valuable insights into its adoption and outcomes in South Korea. Data collection reflects the growing popularity of this procedure, with a significant proportion of REPROG procedures being performed in South Korea. REPROG showed a shorter hospital stay than CLG, reinforcing its feasibility as an reasonable treatment option for gastric cancer in selected settings with experienced surgeons.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1

Details of surgical instruments and access methods by robotic platform

Journal of Gastric Cancer

Supplementary Table 2

Clinico-pathologic features and surgical outcomes of REPROG cases in 2019 and other years (2014–2018, 2020–2023)

Supplementary Table 3

Clinicopathological features and surgical outcomes of REPROG and multiport CLG before propensity score matching

REFERENCES

1. Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, et al. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2024;74:229-263. PUBMED | CROSSREF
2. Ilic M, Ilic I. Epidemiology of stomach cancer. World J Gastroenterol 2022;28:1187-1203. PUBMED | CROSSREF
3. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, et al. Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2021;71:209-249. PUBMED | CROSSREF
4. Mocellin S. The effect of lymph node dissection on the survival of patients with operable gastric carcinoma. JAMA Oncol 2016;2:1363-1364. PUBMED | CROSSREF
5. Songun I, Putter H, Kranenbarg EM, Sasako M, van de Velde CJ. Surgical treatment of gastric cancer: 15-year follow-up results of the randomised nationwide Dutch D1D2 trial. Lancet Oncol 2010;11:439-449. PUBMED | CROSSREF
6. Kim TH, Kim IH, Kang SJ, Choi M, Kim BH, Eom BW, et al. Korean practice guidelines for gastric cancer 2022: an evidence-based, multidisciplinary approach. J Gastric Cancer 2023;23:3-106. PUBMED | CROSSREF
7. Kim IH, Kang SJ, Choi W, Seo AN, Eom BW, Kang B, et al. Korean practice guidelines for gastric cancer 2024: an evidence-based, multidisciplinary approach (update of 2022 guideline). J Gastric Cancer 2025;25:5-114. PUBMED | CROSSREF
8. Noshiro H, Ikeda O, Urata M. Robotically-enhanced surgical anatomy enables surgeons to perform distal gastrectomy for gastric cancer using electric cautery devices alone. Surg Endosc 2014;28:1180-1187. PUBMED | CROSSREF
9. Ojima T, Nakamura M, Hayata K, Kitadani J, Katsuda M, Takeuchi A, et al. Short-term outcomes of robotic gastrectomy vs laparoscopic gastrectomy for patients with gastric cancer: a randomized clinical trial. JAMA Surg 2021;156:954-963. PUBMED | CROSSREF
10. Hwang J, Kim KY, Park SH, Cho M, Kim YM, Kim HI, et al. Long-term oncologic outcomes of robotic total gastrectomy for advanced gastric cancer. J Gastric Cancer 2024;24:451-463. PUBMED | CROSSREF
11. Yu X, Zhu L, Zhang Y, Feng Q. Robotic versus laparoscopic gastrectomy for gastric cancer in patients with obesity: systematic review and meta-analysis. Front Oncol 2023;13:1158804. PUBMED | CROSSREF
12. Yang SY, Roh KH, Kim YN, Cho M, Lim SH, Son T, et al. Surgical outcomes after open, laparoscopic, and robotic gastrectomy for gastric cancer. Ann Surg Oncol 2017;24:1770-1777. PUBMED | CROSSREF
13. Lu J, Zheng CH, Xu BB, Xie JW, Wang JB, Lin JX, et al. Assessment of robotic versus laparoscopic distal gastrectomy for gastric cancer: a randomized controlled trial. Ann Surg 2021;273:858-867. PUBMED | CROSSREF
14. Wang CY, Chen YH, Huang TS. Reduced-port robotic radical gastrectomy for gastric cancer: a single-institute experience. BMC Surg 2022;22:198. PUBMED | CROSSREF
15. Choi S, Son T, Song JH, Lee S, Cho M, Kim YM, et al. Intracorporeal esophagojejunostomy during reduced-port totally robotic gastrectomy for proximal gastric cancer: a novel application of the Single-Site® plus 2-port system. J Gastric Cancer 2021;21:132-141. PUBMED | CROSSREF
16. Seo WJ, Son T, Roh CK, Cho M, Kim HI, Hyung WJ. Reduced-port totally robotic distal subtotal gastrectomy with lymph node dissection for gastric cancer: a modified technique using Single-Site® and two additional ports. Surg Endosc 2018;32:3713-3719. PUBMED | CROSSREF
17. Choi S, Kim NY, Kim YN, Park SH, Kim KY, Cho M, et al. Fluorescence-guided two-port robotic gastrectomy versus conventional laparoscopic gastrectomy: a nonrandomized controlled trial. Ann Surg Open 2023;4:e318. PUBMED | CROSSREF

https://doi.org/10.5230/jgc.2025.25.e42

18. Lee S, Kim JK, Kim YN, Jang DS, Kim YM, Son T, et al. Safety and feasibility of reduced-port robotic distal gastrectomy for gastric cancer: a phase I/II clinical trial. Surg Endosc 2017;31:4002-4009. PUBMED | CROSSREF
19. Park SH, Kim YN, Hwang J, Kim KY, Cho M, Kim YM, et al. Safety and feasibility of reduced-port robotic distal gastrectomy for gastric cancer: a phase I/II clinical trial using the da Vinci Single Port (SP) robotic system. Sci Rep 2023;13:18578. PUBMED | CROSSREF
20. Yoshikawa T, Hayashi T, Nishino M, Ogawa R, Fujisaki Y, Honda S, et al. A new hybrid robotic surgery by minimally invasive laparoscopic and robotic (MILAR) system using da Vinci single-port (SP) in distal gastrectomy for gastric cancer. Asian J Endosc Surg 2025;18:e13401. PUBMED | CROSSREF
21. Cho E, Kang MH, Choi KS, Suh M, Jun JK, Park EC. Cost-effectiveness outcomes of the national gastric cancer screening program in South Korea. Asian Pac J Cancer Prev 2013;14:2533-2540. PUBMED | CROSSREF
22. Kim HH. KLASS (Korean Laparoendoscopic Gastrointestinal Surgery Study Group) trials: a 20-year great journey in advancing surgical clinical research for gastric cancer. Ann Surg Treat Res 2025;108:1-11. PUBMED | CROSSREF
23. Kim JW. Current issues in reduced-port gastrectomy: a comprehensive review. J Gastric Cancer 2024;24:57-68. PUBMED | CROSSREF
24. Information Committee of the Korean Gastric Cancer Association. Korean Gastric Cancer Association-led nationwide survey on surgically treated gastric cancers in 2019. J Gastric Cancer 2021;21:221-235. PUBMED | CROSSREF
25. Information Committee of Korean Gastric Cancer Association. Korean Gastric Cancer Association nationwide survey on gastric cancer in 2014. J Gastric Cancer 2016;16:131-140. PUBMED | CROSSREF
26. Eom SS, Park SH, Eom BW, Man Yoon H, Kim YW, Ryu KW. Real-world compliance of surgical treatment according to the Korean gastric cancer guideline 2018: evaluation from the nationwide survey data 2019 in Korea. J Gastric Cancer 2023;23:535-548. PUBMED | CROSSREF
27. Jeong SH, Park M, Seo KW, Kim RB, Min JS; Information Committee of the Korean Gastric Cancer Association. A comparative study of postoperative complications associated with distal gastrectomy and pylorus-preserving gastrectomy among gastric cancer patients based on nationwide survey data and propensity score weighting. Cancers (Basel) 2024;16:2203. PUBMED | CROSSREF
28. Jeong SH, Yoo MW, Park M, Seo KW, Min JS; Information Committee of the Korean Gastric Cancer Association. Complication after gastrectomy for gastric cancer according to hospital volume: based on Korean Gastric Cancer Association-led nationwide survey data. J Gastric Cancer 2023;23:462-475. PUBMED | CROSSREF
29. Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. Ann Surg 2004;240:205-213. PUBMED | CROSSREF
30. Brierley JD, Gospodarowicz MK, Wittekind C. TNM Classification of Malignant Tumours. 8th ed. Hoboken (NJ):Wiley-Blackwell, 2017.
31. Xie FN, Chen J, Li ZY, Bai B, Song D, Xu S, et al. Impact of laparoscopic converted to open gastrectomy on short- and long-term outcomes of patients with locally advanced gastric cancer: a propensity score-matched analysis. J Gastrointest Surg 2021;25:2484-2494. PUBMED | CROSSREF
32. Yan Y, Ou C, Cao S, Hua Y, Sha Y. Laparoscopic vs. open distal gastrectomy for locally advanced gastric cancer: a systematic review and meta-analysis of randomized controlled trials. Front Surg 2023;10:1127854. PUBMED | CROSSREF
33. Garbarino GM, Laracca GG, Lucarini A, Piccolino G, Mercantini P, Costa A, et al. Laparoscopic versus open surgery for gastric cancer in western countries: a systematic review and meta-analysis of short- and long-term outcomes. J Clin Med 2022;11:3590. PUBMED | CROSSREF
34. Kim W, Kim HH, Han SU, Kim MC, Hyung WJ, Ryu SW, et al. Decreased morbidity of laparoscopic distal gastrectomy compared with open distal gastrectomy for stage i gastric cancer: short-term outcomes from a multicenter randomized controlled trial (KLASS-01). Ann Surg 2016;263:28-35. PUBMED | CROSSREF
35. Chung JH, Hwang J, Park SH, Kim KY, Cho M, Kim YM, et al. Identifying the best candidates for reduced port gastrectomy. Gastric Cancer 2024;27:176-186. PUBMED | CROSSREF
36. Kim TJ, Lee YY, An JJ, Choi CH, Lee JW, Kim BG, et al. Does single-port access (SPA) laparoscopy mean reduced pain? A retrospective cohort analysis between SPA and conventional laparoscopy. Eur J Obstet Gynecol Reprod Biol 2012;162:71-74. PUBMED | CROSSREF
37. Wong JS, Cheung YS, Fong KW, Chong CC, Lee KF, Wong J, et al. Comparison of postoperative pain between single-incision laparoscopic cholecystectomy and conventional laparoscopic cholecystectomy: prospective case-control study. Surg Laparosc Endosc Percutan Tech 2012;22:25-28. PUBMED | CROSSREF

38. Kang DY, Kim HG, Kim DY. Reduced-port laparoscopic distal gastrectomy in obese gastric cancer patients. PLoS One 2021;16:e0255855. PUBMED | CROSSREF

39. Lee HH, Jeong O, Seo HS, Choi MG, Ryu SY, Sohn TS, et al. Long-term oncological outcomes of reduced three-port laparoscopic gastrectomy for early-stage gastric carcinoma: a retrospective large-scale multi-institutional study. J Gastric Cancer 2021;21:93-102. PUBMED | CROSSREF

40. Roh CK, Choi S, Seo WJ, Cho M, Choi YY, Son T, et al. Comparison of surgical outcomes between integrated robotic and conventional laparoscopic surgery for distal gastrectomy: a propensity score matching analysis. Sci Rep 2020;10:485. PUBMED | CROSSREF

41. Lee K, Suh M, Jun JK, Choi KS. Impact of the COVID-19 pandemic on gastric cancer screening in South Korea: results from the Korean National Cancer Screening Survey (2017-2021). J Gastric Cancer 2022;22:264-272. PUBMED | CROSSREF

42. Hwang J, Moon J, Kim KY, Park SH, Cho M, Kim YM, et al. Enhanced recovery and comparable long-term outcomes in reduced-port robotic distal gastrectomy versus conventional laparoscopic distal gastrectomy: a propensity score-matched analysis of single-center experience. Eur J Surg Oncol 2025;51:110137. PUBMED | CROSSREF