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Special Article

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Korean Gastric Cancer Association-Led Nationwide Survey on Surgically Treated Gastric Cancers in 2023

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ABSTRACT

Purpose: Since 1995, the Korean Gastric Cancer Association (KGCA) has been periodically conducting nationwide surveys on patients with surgically treated gastric cancer. This study details the results of the survey conducted in 2023.

Materials and Methods: The survey was conducted from March to December 2024 using a standardized case report form. Data were collected on 86 items, including patient demographics, tumor characteristics, surgical procedures, and surgical outcomes. The results of the 2023 survey were compared with those of previous surveys.

Results: Data from 12,751 cases were collected from 66 institutions. The mean patient age was 64.6 years, and the proportion of patients aged ≥71 years increased from 9.1% in 1995 to 31.7% in 2023. The proportion of upper-third tumors slightly decreased to 16.8% compared to 20.9% in 2019. Early gastric cancer accounted for 63.1% of cases in 2023. Regarding operative procedures, a totally laparoscopic approach was most frequently applied (63.2%) in 2023, while robotic gastrectomy steadily increased to 9.5% from 2.1% in 2014. The most common anastomotic method was the Billroth II procedure (48.8%) after distal gastrectomy and double-tract reconstruction (51.9%) after proximal gastrectomy in 2023. However, the proportion of esophago-gastrostomy with anti-reflux procedures increased to 30.9%. The rates of post-operative mortality and overall complications were 1.0% and 15.3%, respectively.

Conclusions: The results of the 2023 nationwide survey demonstrate the current status of gastric cancer treatment in Korea. This information will provide a basis for future gastric cancer research.

Keywords: Stomach neoplasm; Health care survey; Korea

INTRODUCTION

Gastric cancer remains a major public health issue, particularly in East Asia, where its incidence and mortality rates are among the highest globally [1]. In South Korea, gastric cancer is one of the most prevalent cancers. According to the latest National Cancer Registry statistics for 2021, gastric cancer accounted for approximately 10.6% of all cancer cases, making it the fourth most commonly diagnosed cancer overall. Among men, it was the second most frequent cancer, while among women, it ranked fifth [2]. Despite its high prevalence, advances in national cancer screening programs and early diagnostic techniques have led to a steady increase in early gastric cancer (EGC) detection, contributing to improved patient outcomes [3].

While surgical resection remains the primary gastric cancer treatment, minimally invasive approaches such as laparoscopic and robotic surgeries are becoming increasingly common. To systematically track and analyze evolving trends in gastric cancer treatment, the Korean Gastric Cancer Association (KGCA) has conducted nationwide surveys periodically since 1995 [4]. The 5-year interval was recently reduced to a four-year interval to align with the term of the association's executive board. Accordingly, data collection for the most recent survey occurred in 2023. This survey provides comprehensive data on patient demographics, pathological characteristics, surgical methods, and operative outcomes, serving as a valuable resource for understanding treatment advancements and trends.

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The 2019 nationwide survey, which collected data on 14,076 cases from 68 institutions, highlighted important trends in gastric cancer treatment, including an increased proportion of early and upper-third gastric cancers, widespread adoption of laparoscopic techniques, and the first-ever reporting of surgical morbidity and mortality rates [4]. The nationwide survey data collected over the years has served as a critical foundation for diverse research endeavors. Numerous studies have utilized this comprehensive dataset, yielding clinically significant findings that have been published in various academic journals [5-9]. These efforts underscore the importance of the nationwide survey in providing robust and reliable data that continue to advance gastric cancer research and inform evidence-based clinical practice.

Building on the insights from previous surveys, this study aims to present the findings of the 2023 nationwide survey on surgically treated gastric cancer. By analyzing the latest data, we aim to identify recent trends in patient characteristics, surgical techniques, and treatment outcomes, providing a comprehensive overview of the current state of gastric cancer management in South Korea. These findings will inform future clinical decision-making and research directions.

MATERIALS AND METHODS

Data collection

This survey was conducted to retrieve information regarding all the new patients treated surgically in 2023. Before data collection, emails were sent to all KGCA members to ascertain their willingness to participate in the current survey and to request that they designate representative surgeons for each hospital to promote active correspondence. The case report form was sent to each representative surgeon in the hospital who agreed to participate in the current national survey program. Data collection was conducted from March 2024 to December 2024.

The KGCA information committee reviewed the collected data and filtered suspected incorrect or missing data. The incorrect, missing, or equivocal data were queried back to the data manager in each hospital. Missing values were either treated as "not available (NA)" in the analysis of categorical data or were excluded from the analysis of continuous data.

This study followed the ethical principles for medical research in accordance with the Declaration of Helsinki and obtained approval from the relevant Institutional Review Board for data collection. (representative approval No. XC24RADI0052). Patient consent was waived as the researchers collected anonymized data.

Survey data

The survey dataset consisted of 86 items encompassing a wide range of information, including patient demographics and medical history, surgical details, post-operative outcomes, pathology findings, and information about chemotherapy. Details about the survey items are included in **Supplementary Table 1**. Each piece of data that was significantly altered or added in this survey compared to the previous survey is highlighted for easy identification. In the patients' demographic characteristics, smoking and tobacco history were added. Patients' underlying comorbidities were estimated as yes or no in each specific disease, such as diabetes and hypertension. Detailed information regarding the previous

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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endoscopic submucosal dissection (ESD) procedure was included. The status of the surgical procedure was categorized as upfront surgery, neoadjuvant, or conversion surgery, depending on the pre-surgery treatment.

In the surgical information, information regarding emergency surgery and the specific needle grasper utilized in reduced-port surgery was added. Additionally, data related to intraoperative blood transfusions and the placement of drainage tubes were included. As a significant modification, the type of trocar used in reduced-port surgery was specified. Furthermore, to reflect the diversity of anastomosis methods following proximal gastrectomy (PG), double-flap esophago-gastrostomy and esophago-gastrostomy with an anti-reflux procedure were incorporated.

From the 2019 survey, post-operative complications and mortality were also examined. A post-operative complication was defined as any deviation from the normal clinical post-operative course within 30 days after surgery. Post-operative complications were classified as follows: anastomosis leakage, anastomosis stricture, duodenal stump leakage, intra-abdominal bleeding, luminal bleeding, pancreatic fistula, intra-abdominal abscess, fluid collection, wound problem, mechanical ileus, pneumonia, cerebrovascular accident, heart problem, chyle ascites, and others. Chyle ascites was added to the types of complication categories in the current survey. Additionally, the complication detection period was also investigated [10].

Regarding pathological information, histological types were classified according to the 2010 World Health Organization (WHO) classification [11]. Pathological staging was determined according to the eighth edition of the American Joint Committee on Cancer tumor-node-metastasis (TNM) classification system [12]. Regarding the pathologic data, the depth of invasion was added, which includes lamina propria, muscularis mucosae, sm1, sm2, and sm3. Finally, the types of adjuvant chemotherapy and other regimens were investigated.

Statistical analysis

Continuous variables were presented as averages and standard deviations, and nominal variables were presented as numbers and proportions. Descriptive analyses were conducted to compare the results of the 2023 survey with the previous results since 1995.

RESULTS

Participating institutions and patients

Sixty-six institutions participated in this survey, and data were collected from 12,751 patients who underwent surgery for gastric adenocarcinoma in 2023. The annual number of surgeries was more than 1,000 at two institutions and between 500 and 999 at four other institutions. These six institutions accounted for 43.6% (5,555/12,751) of the total number of surgeries. Nine institutions performed 200–499 surgeries, 18 performed 100–199 surgeries, and 33 performed fewer than 100 surgeries.

Age, sex, and body mass index (BMI) distribution

Patients' age, sex, pre-operative BMI, and upfront chemotherapy are presented in **Table 1**. The mean age was 64.6±11.6 years, which was slightly higher than that reported in the 2019 survey (62.9±11.9 years). The proportion of patients aged ≥71 years increased from 9.1% in

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Table 1. Age, sex, BMI distribution, and upfront chemotherapy according to the study period

Characteristics	Subgroup	1995 (n=5,356)	1999 (n=6,314)	2004 (n=11,293)	2009 (n=14,658)	2014 (n=15,613)	2019 (n=14,076)	2023 (n=12,751)
Age (yr)					59.2±11.9	60.9±12.1	62.9±11.9	64.6±11.6
Age distribution (yr)	≤30	103 (1.9)	115 (1.8)	142 (1.3)	134 (0.9)	88 (0.6)	59 (0.4)	41 (0.3)
	31–40	612 (11.4)	622 (9.9)	855 (7.6)	972 (6.6)	810 (5.2)	491 (3.5)	304 (2.4)
	41–50	910 (17.0)	1,033 (16.4)	2,106 (18.7)	2,492 (17.0)	2,313 (14.8)	1,625 (11.5)	1,237 (9.7)
	51–60	1,727 (32.2)	1,848 (29.3)	2,732 (24.2)	3,762 (25.7)	4,257 (27.3)	3,688 (26.2)	2,702 (21.2)
	61–70	1,516 (28.3)	1,971 (31.2)	3,866 (34.2)	4,527 (30.9)	4,195 (26.9)	4,162 (29.6)	4,429 (34.7)
	≥71	488 (9.1)	725 (11.5)	1,589 (14.1)	2,768 (18.9)	3,949 (25.3)	4,051 (28.8)	4,038 (31.7)
Sex	Male	3,569 (66.5)	3,949 (62.5)	7,586 (67.2)	9,816 (67.0)	10,298 (66.0)	9,228 (65.6)	8,338 (65.4)
	Female	1,799 (33.5)	2,368 (37.5)	3,705 (32.8)	4,839 (33.0)	5,315 (34.0)	4,848 (34.4)	4,413 (34.6)
	Ratio	1.98:1	1.67:1	2.05:1	2.03:1	1.94:1	1.90:1	1.89:1
BMI (kg/m^2)		NA	NA	NA	NA	23.4±3.3	23.9±3.4	23.9±3.5
BMI distribution (kg/m^2)	<18.5	NA	NA	NA	NA	900 (5.9)	667 (4.8)	584 (4.7)
	18.5–24.9	NA	NA	NA	NA	10,228 (65.4)	8,343 (59.9)	7,446 (60.2)
	25.0–29.9	NA	NA	NA	NA	3,950 (25.7)	4,320 (31.0)	3,925 (31.7)
	≥30	NA	NA	NA	NA	462 (3.0)	600 (4.3)	416 (3.4)
Upfront chemotherapy	No	NA	NA	NA	NA	NA	NA	12,283 (97.4)
	Neoadjuvant	NA	NA	NA	NA	NA	NA	155 (1.2)
	Palliative	NA	NA	NA	NA	NA	NA	173 (1.4)

Values are presented as mean ± standard deviation or number (%). The sum of the percentages may not equal 100% because of rounding.
BMI = body mass index; NA = not available (items not included in the survey).

1995 to 31.7% in 2023, whereas the proportion of patients aged ≤40 years decreased from 13.3% in 1995 to 2.7% in 2023.

The male-to-female ratio was 1.89:1, with little change since 1995. In the 2023 survey, the mean BMI was 23.9±3.5 kg/m^2, with 60.2% of patients having a normal BMI (<25 kg/m^2) according to the WHO BMI classification. Among all gastric cancer patients, 97.4% underwent surgical treatment first, 1.2% received neoadjuvant chemotherapy, and 1.4% received palliative chemotherapy in 2023.

Histopathological characteristics of gastric cancer

The majority of tumors were single tumors (95.8%), followed by two tumors (3.7%) and three or more tumors (0.5%). In terms of tumor location, the lower third of the stomach was the most common site (53.1%), with the proportion of tumors in the upper third decreasing slightly to 16.8% compared to 2019 (**Table 2**, **Fig. 1**). The most common tumor size was between 2.0 and 3.9 cm. The macroscopic type showed no significant difference compared to the 2019 results: EGC type IIc was the most common; Borrmann type 3 was predominant among advanced gastric cancer (AGC). The distribution of tumor differentiation changed by 2023, with a decrease in poorly differentiated tumors (17.2%) and an increase in signet ring cell carcinoma tumors (23.8%).

Tumor-node-metastasis stages

The proportion of EGC (pT1, Nany) was comparable in 2019 and 2023 at 63.6% and 63.1%, respectively; however, the ratio of T1b (31.8%) was higher than that of T1a (31.3%) (**Table 3**, **Fig. 2**). The proportion of node positivity increased to 30.1%. There was an increase in advanced stage cancers (Stage III and IV), observed in 21.3% of cases in 2023 compared to 19.7% in 2019 (**Fig. 3**). **Supplementary Table 2** presents a detailed post-chemotherapeutic pathologic (yp) classification. The frequencies of ypT3 and ypT4a were high, at 24.1% (78/324) and 23.1% (75/324), respectively, among patients who underwent surgery after chemotherapy, while no residual tumor (ypT0) was observed in 7.1% of the cases. Lymph node metastasis and distant metastasis were confirmed in 63.6% and 42.0% of patients who

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Table 2. Histopathological characteristics of gastric cancer

Factor	Subgroup	1995	1999	2004	2009	2014	2019	2023
Location	Lower	2,374 (49.3)	2,919 (49.6)	5,347 (49.8)	7,919 (56.0)	7,959 (53.8)	6,422 (47.1)	6,476 (53.1)
	Middle	1,798 (37.4)	2,050 (34.8)	3,635 (33.8)	4,045 (28.6)	4,233 (28.6)	4,100 (30.1)	3,460 (28.4)
	Upper	539 (11.2)	738 (12.5)	1,493 (13.9)	1,895 (13.4)	2,365 (16.0)	2,844 (20.9)	2,050 (16.8)
	Entire	100 (2.1)	178 (3.0)	299 (2.8)	292 (2.1)	244 (1.6)	272 (2.0)	203 (1.7)
Tumor size (cm)	<2.0	812 (19.5)	1,164 (21.8)	2,675 (24.8)	3,063 (22.0)	3,300 (22.3)	3,146 (23.5)	2,760 (22.7)
	2.0–3.9	1,342 (32.3)	1,650 (30.9)	3,528 (32.7)	5,212 (37.5)	5,751 (38.8)	5,187 (38.8)	4,995 (41.0)
	4.0–5.9	972 (23.4)	1,183 (22.1)	2,235 (20.7)	2,821 (20.3)	2,990 (20.2)	2,689 (20.1)	2,258 (18.5)
	6.0–7.9	548 (13.2)	598 (13.1)	1,215 (11.3)	1,437 (10.3)	1,359 (9.2)	1,180 (8.8)	1,069 (8.8)
	8.0–9.9	270 (6.5)	364 (6.8)	626 (5.8)	673 (4.8)	670 (4.5)	538 (4.0)	520 (4.3)
	≥10.0	215 (5.2)	286 (5.4)	508 (4.7)	690 (5.0)	754 (5.1)	624 (4.7)	578 (4.7)
Macroscopic type	EGC type I	106 (8.6)	124 (8.0)	253 (5.9)	400 (5.1)	401 (4.6)	332 (4.0)	311 (4.0)
	EGC type IIa	138 (11.2)	138 (8.9)	435 (10.2)	937 (12.0)	1,222 (13.9)	1,262 (15.2)	1,376 (17.8)
	EGC type IIb	241 (19.6)	293 (18.8)	902 (21.1)	1,578 (20.3)	1,938 (22.1)	2,126 (25.5)	1,743 (22.5)
	EGC type IIc	695 (56.6)	901 (57.9)	2,346 (54.9)	4,408 (56.6)	4,757 (54.1)	4,233 (50.9)	3,911 (50.5)
	EGC type III	49 (4.0)	99 (6.4)	339 (7.9)	462 (5.9)	470 (5.3)	370 (4.4)	399 (5.2)
	Borrmann 1	159 (4.9)	137 (4.0)	198 (3.6)	270 (4.8)	274 (5.0)	192 (4.0)	227 (5.3)
	Borrmann 2	763 (23.6)	825 (23.8)	1,165 (21.3)	1,235 (21.9)	1,242 (22.5)	1,030 (21.2)	963 (22.3)
	Borrmann 3	1,867 (57.7)	1,980 (57.1)	3,377 (61.8)	3,464 (61.3)	3,338 (60.4)	2,983 (61.4)	2,581 (59.7)
	Borrmann 4	445 (13.8)	523 (15.1)	720 (13.2)	679 (12.0)	674 (12.2)	581 (12.0)	442 (10.2)
	Borrmann 5	NA	NA	NA	NA	NA	73 (1.5)	109 (2.5)
Histology	Papillary	NA	NA	61 (0.6)	168 (1.2)	86 (0.6)	90 (0.7)	101 (0.8)
	Tubular WD	NA	NA	1,517 (14.7)	1,761 (12.5)	1,733 (11.5)	1,359 (10.0)	1,364 (11.1)
	Tubular MD	NA	NA	3,091 (29.9)	4,283 (30.3)	4,538 (30.2)	4,428 (32.5)	4,080 (33.3)
	Tubular PD	NA	NA	3,721 (35.9)	4,820 (34.1)	4,288 (28.5)	3,630 (26.6)	2,110 (17.2)
	PCC (SRC)	NA	NA	1,597 (15.4)	2,686 (19.0)	2,715 (18.1)	2,603 (19.1)	2,913 (23.8)
	Mucinous	NA	NA	249 (2.4)	324 (2.3)	380 (2.5)	187 (1.4)	199 (1.6)
	Mixed carcinoma*	NA	NA	NA	NA	714 (4.7)	930 (6.8)	969 (7.9)
	Others	NA	NA	118 (1.1)	100 (0.7)	573 (3.8)	398 (3.0)	498 (4.1)

Values are presented as number (%). The sum of the percentages may not equal 100% because of rounding.
EGC = early gastric cancer; WD = well differentiated; MD = moderately differentiated; PD = poorly differentiated; PCC = poorly cohesive carcinoma; SRC = signet ring cell carcinoma; NA = not available (items not included in the survey).
*Mixed carcinomas display a mixture of discrete, morphologically identifiable glandular (tubular/papillary) and poorly cohesive cellular histological components (signet ring cell).

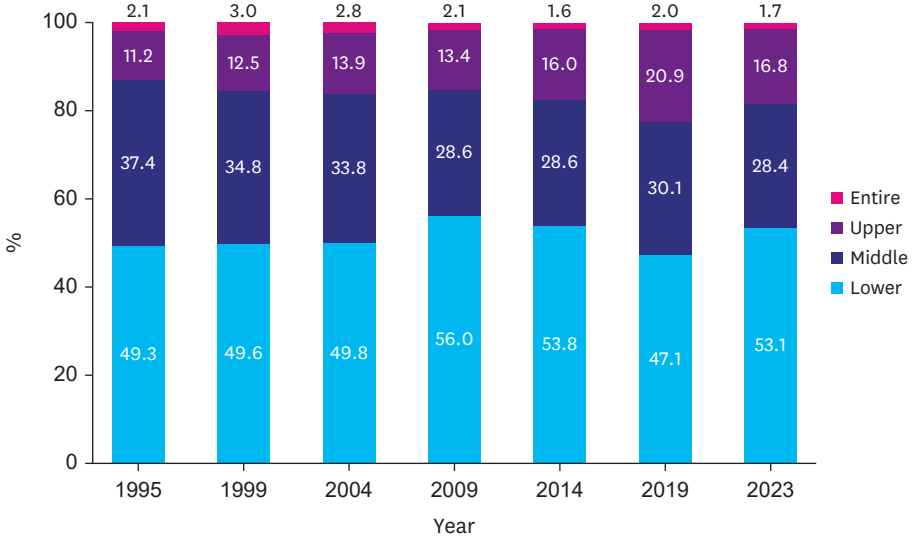

Fig. 1. Distribution of tumor location over time.

underwent chemotherapy followed by surgery, respectively. On average, 37.6 lymph nodes were harvested, with more than 16 lymph nodes obtained in 96.1% of the patients.

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Table 3. Tumor-node-metastasis stages according to the American Joint Committee on Cancer classification, 8th edition

Factor	Subgroup	2009	2014	2019	2023
Depth of invasion	T1a (mucosa)	4,507 (32.0)	5,145 (34.6)	4,667 (34.5)	3,823 (31.3)
	T1b (submucosa)	3,618 (25.7)	3,935 (26.4)	3,945 (29.1)	3,885 (31.8)
	T2 (proper muscle)	1,726 (12.3)	1,668 (11.2)	1,327 (9.8)	1,288 (10.5)
	T3 (subserosa)	2,038 (14.5)	1,822 (12.2)	1,758 (13.0)	1,573 (12.9)
	T4a (serosa)	1,799 (12.8)	1,890 (12.7)	1,611 (11.9)	1,420 (11.6)
	T4b (adjacent organ)	388 (2.8)	421 (2.8)	226 (1.7)	227 (1.9)
Lymph node metastasis	N0	9,176 (65.5)	10,201 (68.1)	9,536 (71.3)	8,546 (69.9)
	N1 (1–2)	1,516 (10.8)	1,629 (10.9)	1,370 (10.2)	1,349 (11.0)
	N2 (3–6)	1,361 (9.7)	1,276 (8.5)	1,044 (7.8)	989 (8.1)
	N3a (7–15)	1,165 (8.3)	1,072 (7.2)	866 (6.5)	816 (6.7)
	N3b (≥16)	792 (5.7)	793 (5.3)	567 (4.2)	522 (4.3)
Distant metastasis	M0	13,511 (94.5)	14,404 (95.5)	13,167 (94.9)	11,904 (93.7)
	M1	788 (5.5)	684 (4.5)	711 (5.1)	804 (6.3)
Stage	IA	7,127 (50.5)	8,051 (53.4)	7,703 (56.1)	6,917 (54.7)
	IB	1,461 (10.3)	1,582 (10.5)	1,291 (9.4)	1,283 (10.2)
	IIA	1,129 (8.0)	1,160 (7.7)	1,102 (8.0)	962 (7.6)
	IIB	987 (6.2)	975 (6.5)	918 (6.7)	787 (6.3)
	IIIA	1,118 (7.1)	1,138 (7.5)	863 (6.3)	842 (6.7)
	IIIB	925 (5.8)	869 (5.8)	704 (5.1)	641 (5.1)
	IIIC	582 (3.7)	629 (4.2)	430 (3.1)	399 (3.2)
	IV	788 (5.6)	684 (4.5)	711 (5.2)	804 (6.3)
Harvested lymph nodes		38.3±17.8	41.6±20.0	38.9±18.2	37.6±15.3
	<16	975 (7.0)	514 (3.4)	639 (4.8)	471 (3.9)
	≥16	12,978 (93.0)	14,435 (96.6)	12,733 (95.2)	11,633 (96.1)

Values are presented as mean ± standard deviation or number (%). The sum of the percentages does not equal 100% because of rounding. Post-chemotherapy pathologic (yp) tumor-node-metastasis classifications are included in this analysis.

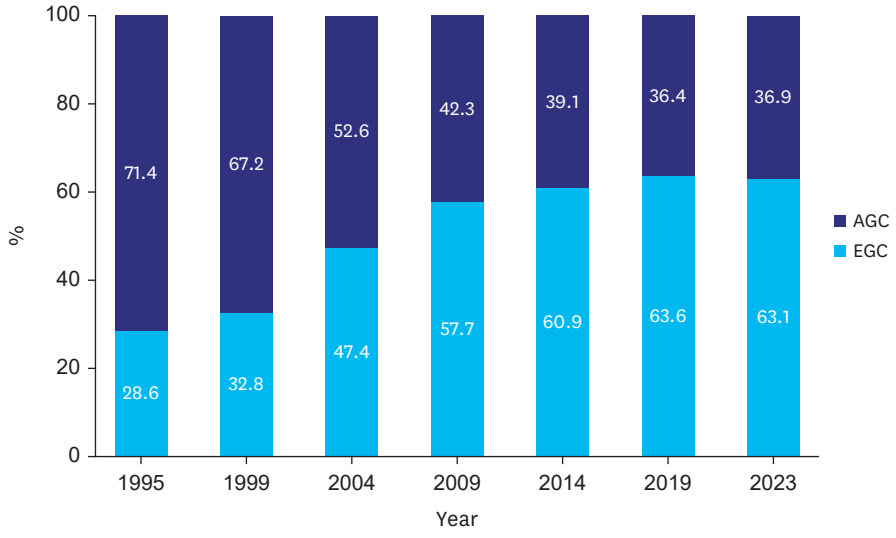

Fig. 2. Proportions of early and advanced gastric cancers over time.
AGC = advanced gastric cancer; EGC = early gastric cancer.

Surgery-related factors

The surgical approach (open vs. laparoscopic) has significantly evolved over time. The proportion of minimally invasive surgeries (laparoscopic/robotic) increased dramatically from 6.6% in 2004 to 80.3% in 2023 (**Fig. 4**). Detailed analysis of laparoscopic methods, including laparoscopy-assisted and totally laparoscopic approaches, has been conducted since 2014. The totally laparoscopic approach exhibited a consistent upward trend, increasing to 63.2% in 2023 (**Table 4**). In contrast, laparoscopy-assisted approaches decreased by 7.7%

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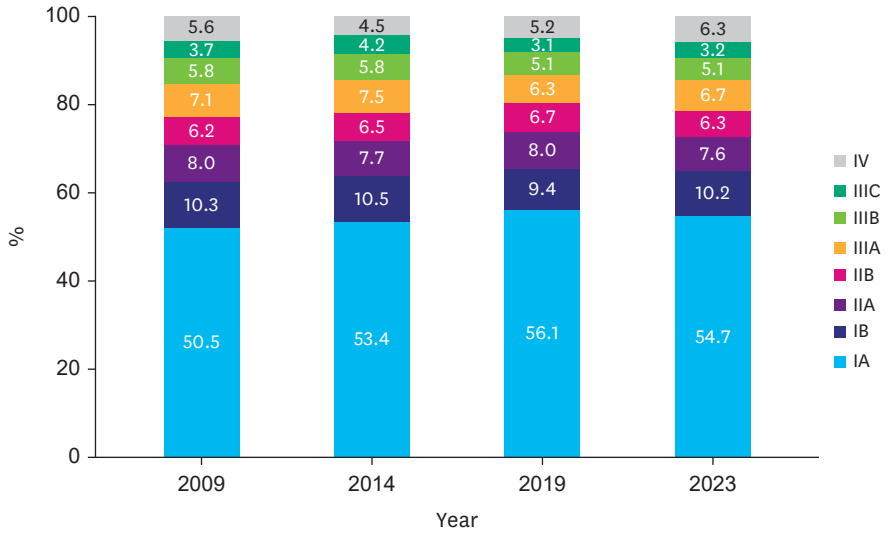

Fig. 3. Proportions of pathological stages according to the American Joint Committee on Cancer, 8th edition.

compared to the 2014 and 2019 data. Robotic approaches, although still less common, increased steadily from 2.1% in 2014 to 9.5% in 2023.

Distal gastrectomy (DG) (72.3%) remained the most prevalent type of surgery, followed by total gastrectomy (TG) (18.6%). The proportion of PG has shown a consistent rise since 2014, reaching 3.4% in 2023. The proportion of pylorus-preserving gastrectomy was stable at 1.8%, similar to the 2014 (1.5%) and 2019 (1.7%) rates. As in 2019, most patients (≥95.0%) underwent D1+ or more extensive lymph node dissections, and curative (R0) resections were achieved in 93.9% of the cases.

Reconstruction methods and surgical outcomes by approach

The reconstruction methods are summarized in **Table 5**. In DG, Billroth II reconstruction was the most frequently performed method in 2023 (48.8%), followed by Billroth I (32.1%) and

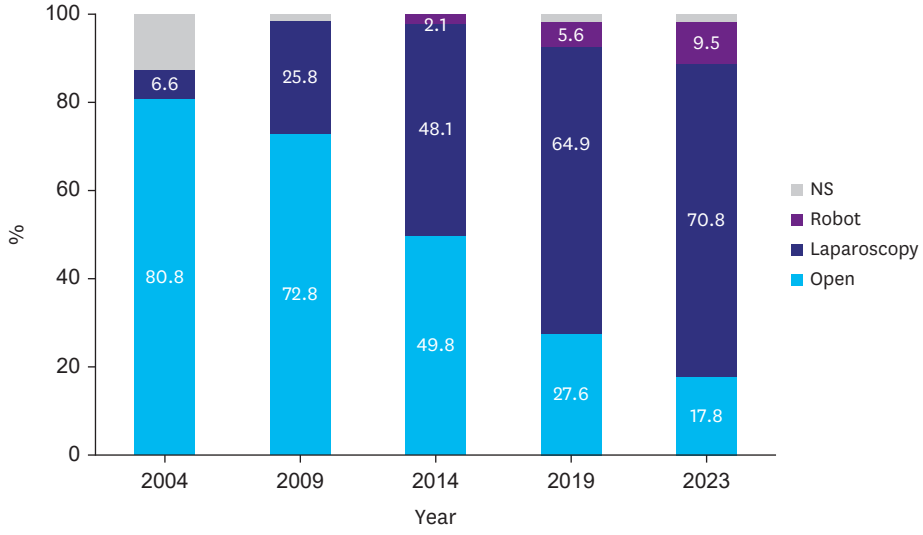

Fig. 4. Proportions of operative approaches over time.
NS = not-specified.

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Table 4. Operative methods and curability

Factor	Subgroup	2004	2009	2014	2019	2023
Approach	Open	9,129 (80.8)	10,672 (72.8)	7,760 (49.8)	3,853 (27.6)	2,261 (17.8)
	Laparoscopy	740 (6.6)	3,783 (25.8)	7,493 (48.1)	9,052 (64.9)	8,990 (70.8)
	Laparoscopic-assisted	NA	NA	2,805 (18.0)	1,369 (9.8)	975 (7.7)
	Totally-laparoscopic	NA	NA	4,688 (30.1)	7,683 (55.1)	8,015 (63.2)
	Robot	NA	NA	325 (2.1)	787 (5.6)	1,201 (9.5)
	Others*	NA	176 (1.2)	1 (<0.1)	258 (1.8)	242 (1.9)
Operation type	DG	7,959 (70.5)	10,375 (70.8)	10,808 (69.2)	10,091 (71.7)	9,173 (72.3)
	TG†	2,645 (23.4)	3,348 (23.3)	3,659 (23.4)	2,855 (20.3)	2,358 (18.6)
	NTG‡	NA	105 (0.7)	119 (0.8)	NA	NA
	PG	119 (1.1)	141 (1.0)	168 (1.1)	365 (2.6)	435 (3.4)
	PPG	29 (0.3)	86 (0.6)	233 (1.5)	242 (1.7)	229 (1.8)
	Segmental resection	NA	NA	10 (0.1)	NA	2 (0)
	Wedge resection	38 (0.3)	51 (0.3)	58 (0.4)	37 (0.3)	37 (0.3)
	Bypass	170 (1.5)	196 (1.3)	163 (1.0)	157 (1.1)	176 (1.4)
	Biopsy or exploration only	243 (2.2)	251 (1.7)	300 (1.9)	239 (1.7)	253 (2.0)
	Others§	NA	105 (0.7)	75 (0.6)	86 (0.6)	32 (0.3)
Combined resection	No			14,176 (92.6)	12,495 (90.6)	11,811 (93.1)
	Yes			1,139 (7.4)	1,299 (9.4)	872 (6.9)
Lymph node dissection	Not done				336 (2.4)	NA
	<D1				83 (0.6)	317 (2.5)
	D1				210 (1.5)	223 (1.8)
	D1+				4,961 (36.1)	5,071 (40.8)
	D2				7,781 (56.7)	6,509 (52.3)
	>D2				357 (2.6)	321 (2.6)
Curability	R0	10,068 (81.9)	13,537 (92.4)	14,043 (89.9)	13,115 (93.2)	11,975 (93.9)
	R1	174 (1.4)	291 (2.0)	223 (1.4)	127 (0.9)	110 (0.9)
	R2	364 (3.0)	257 (1.8)	349 (2.2)	171 (1.2)	231 (1.8)
	No resection	384 (3.1)	513 (3.5)	286 (1.8)	455 (3.2)	380 (3.0)
	NA	303 (2.5)	60 (0.4)	712 (4.6)	208 (1.5)	55 (0.4)

Values are presented as number (%).
NA = not available (items not included in the survey); DG = distal gastrectomy; TG = total gastrectomy; NTG = near total gastrectomy; PG = proximal gastrectomy; PPG = pylorus-preserving gastrectomy.
*Laparoscopy/open exploration or biopsy was first introduced in the 2023 survey.
†TG includes extended total gastrectomy and completion total gastrectomy.
‡Near total gastrectomy has not been included as a choice since the 2019 survey.
§Others include primary repair, Whipple procedure, Ivor Lewis procedure, sleeve gastrectomy, small or large bowel resection, distal pancreatectomy, splenectomy, enucleation, etc.

Roux-en-Y reconstruction (19.2%, including both simple and uncut methods) (**Fig. 5**). Since 2009, the proportion of Billroth II reconstructions has steadily increased, whereas Billroth I reconstructions have gradually declined.

For PG, double tract reconstruction remained the most common method (51.9%), although its frequency has declined compared to previous years. Simple esophago-gastrostomy, double flap esophago-gastrostomy, and esophago-gastrostomy with anti-reflux were performed in 16.7%, 18.1%, and 12.8% of cases, respectively.

The reconstruction methods and surgical outcomes based on the surgical approach in 2023 are detailed in **Table 6**. Billroth I reconstruction was the most frequently used method for laparoscopy-assisted DG (53.6%) and robotic gastrectomy (51.3%), while Billroth II was predominant in totally laparoscopic (52.2%) and open gastrectomy (46.5%).

Stapler usage patterns varied by surgical approach. Circular staplers were primarily used for anastomosis in open (59.4%) and laparoscopy-assisted (53.2%) DG, while linear staplers were utilized in more than 95% of totally laparoscopic and robotic gastrectomy. In TG,

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Table 5. Methods of anastomosis according to the types of gastrectomy

Resection type	Anastomosis	2004	2009	2014	2019	2023
Distal gastrectomy	Billroth I	4,340 (55.3)	6,581 (63.4)	5,426 (51.0)	3,347 (33.6)	2,940 (32.1)
	Billroth II*	3,285 (41.9)	3,437 (33.1)	3,869 (36.4)	4,477 (45.0)	4,473 (48.8)
	with Braun	NA	NA	NA	NA	1,344 (14.6)
	without Braun	NA	NA	NA	NA	3,129 (34.2)
	Roux-en-Y	175 (2.2)	332 (3.2)	933 (8.8)	2,038 (20.5)	1,701 (18.6)
	Uncut Roux-en-Y	NA	NA	404 (3.8)	90 (0.9)	52 (0.6)
	Loop	11 (0.1)	0 (0)	NA	NA	NA
	Jejunal interposition	33 (0.4)	23 (0.2)	0 (0)	NA	NA
	Others	3 (<0.1)	2 (<0.1)	3 (<0.1)	3 (<0.1)	2 (0)
Near total gastrectomy†	Billroth II	46 (67.6)	59 (56.2)	23 (21.5)	NA	NA
	Roux-en-Y	22 (32.4)	39 (37.1)	81 (75.7)	NA	NA
	Jejunal interposition	0 (0)	5 (4.8)	0 (0)	NA	NA
	Uncut Roux-en-Y	NA	NA	3 (2.8)	NA	NA
	Others	0 (0)	2 (1.9)	0 (0)	NA	NA
Total gastrectomy	Roux-en-Y	2,407 (91.1)	3,308 (98.8)	3,418 (97.8)	2,874 (99.3)	2,310 (99.7)
	Loop esophago-jejunostomy	155 (5.9)	18 (0.5)	13 (0.4)	12 (0.4)	2 (0.1)
	Jejunal interposition	49 (1.9)	10 (0.3)	8 (0.2)	5 (0.2)	1 (0)
	Uncut Roux-en-Y	NA	NA	56 (1.6)	NA	NA
	Others	30 (1.1)	12 (0.4)	3 (<0.1)	4 (0.1)	4 (0.2)
Proximal gastrectomy	Double tract	NA	NA	82 (62.1)	286 (81.2)	223 (51.9)
	Esophago-gastrostomy	NA	NA	50 (37.9)	66 (18.8)	205 (47.6)
	Simple Esophago-gastrostomy	NA	NA	NA	NA	72 (16.7)
	Double flap Esophago-gastrostomy	NA	NA	NA	NA	78 (18.1)
	Esophago-gastrostomy with anti-reflux	NA	NA	NA	NA	55 (12.8)
	Others	NA	NA	NA	NA	2 (0.5)
Pylorus-preserving gastrectomy	Gastrogastrostomy	NA	NA	NA	NA	228 (100)

Values are presented as number (%).
NA = not available (items not included in the survey).
*Billroth II reconstruction has been subdivided into "with Braun" and "without Braun" categories starting from this 2023 survey.
†Near total gastrectomy has not been included as a choice since the 2019 survey.

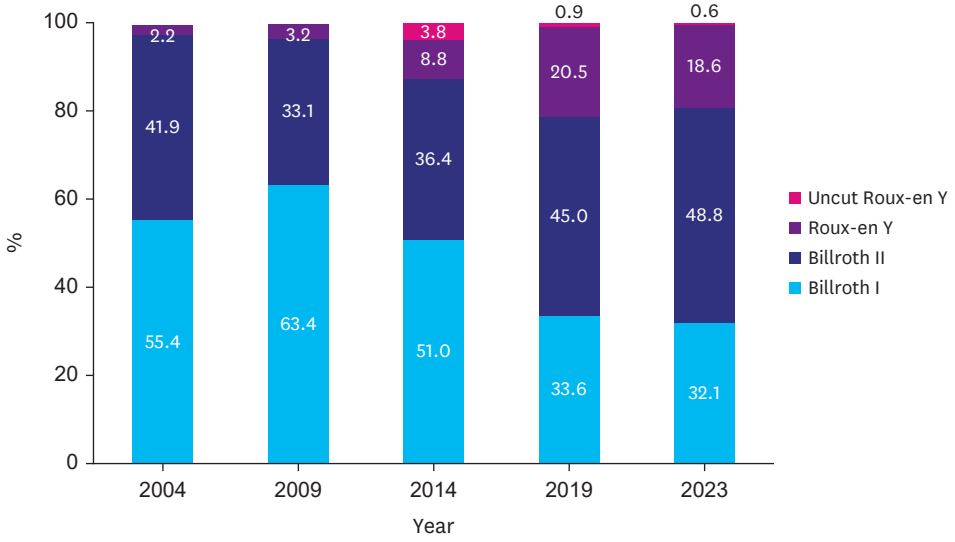

Fig. 5. Proportions of anastomotic method following distal gastrectomy over time.

circular staplers dominated in the open approach (85.5%), whereas linear staplers were more common in other surgical approaches.

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Table 6. Reconstruction methods, type of stapler, amount of blood loss, and operative time according to the surgical approaches in 2023

Operation type	Factors	Subgroup	Open	Laparoscopy-assisted	Totally laparoscopic approach	Robot
Distal gastrectomy	Reconstruction method	Billroth I	446 (38.7)	392 (53.6)	1,626 (25.6)	476 (51.3)
		Billroth II	536 (46.5)	272 (37.2)	3,316 (52.2)	349 (37.6)
		Roux-en-Y	166 (14.4)	67 (9.2)	1,365 (21.5)	103 (11.1)
		Uncut Roux-en-Y	4 (0.3)	0 (0)	48 (0.8)	0 (0)
		Others	1 (0.1)	0 (0)	0 (0)	0 (0)
	Stapler	Linear	506 (35.1)	339 (46.2)	6,125 (96.4)	891 (96.0)
		Circular	857 (59.4)	390 (53.2)	185 (2.9)	31 (3.3)
		Others (Hand-sewing)	80 (5.5)	4 (0.5)	44 (0.7)	6 (0.6)
	Blood loss (mL)		176.1±222.2	89.6±106.0	63.9±92.7	61.6±88.1
	Operation time (min)		154.0±82.6	157.4±85.6	159.7±74.0	182.5±86.7
Total gastrectomy	Stapler	Linear	147 (14.5)	82 (56.9)	922 (86.9)	100 (75.8)
		Circular	862 (85.5)	60 (41.7)	118 (11.1)	31 (23.5)
		Others	5 (0.5)	2 (1.4)	21 (2.0)	1 (0.8)
	Blood loss (mL)		228.2±295.3	35.0±48.7	100.4±129.6	113.8±141.7
	Operation time (min)		178.7±98.0	199.8±121.7	218.9±81.8	233.5±129.2

Values are presented as mean ± standard deviation or number (%).

Blood loss during DG was lowest in the robotic approach compared to other approach. For TG, the laparoscopy-assisted method reported the least blood loss. Robotic gastrectomy required the longest operating time, while open gastrectomy was comparatively faster across both DG and TG.

Post-operative morbidity and mortality

Post-operative mortality data were available for 12,081 patients (94.7%), with 125 patients (1.0%) reported to have died within 30 days post-surgery or during their hospital stay (**Table 7**).

Table 7. Post-operative mortality and complications

Factors	2019	2023
Mortality*		
Survival	13,284 (99.0)	11,765 (99.0)
Death	136 (1.0)	125 (1.0)
Complications within post-operative 30 days†		
Absence	11,340 (85.5)	10,715 (84.7)
Presence	1,930 (14.5)	1,937 (15.3)
Type of complications		
Local complications	1,230 (9.3)	1,186 (9.4)
Anastomotic leakage	138 (1.2)	160 (1.3)
Duodenal stump leakage	76 (0.7)	62 (0.5)
Anastomotic stricture	92 (0.8)	92 (0.7)
Intra-abdominal bleeding	82 (0.7)	73 (0.6)
Intra-luminal bleeding	51 (0.4)	37 (0.3)
Pancreatic fistula	36 (0.3)	64 (0.5)
Fluid collection	250 (2.2)	226 (1.8)
Intra-abdominal abscess	97 (0.9)	113 (0.9)
Wound problem	207 (1.8)	155 (1.2)
Mechanical ileus	174 (1.5)	160 (1.3)
Chyle ascites	NA	44 (0.3)
Systemic complications	375 (3.3)	445 (3.5)
Pulmonary	304 (2.7)	333 (2.6)
Cardiac	59 (0.5)	100 (0.8)
Cerebrovascular	12 (0.1)	12 (0.1)
Others	627 (5.5)	643 (5.1)

Values are presented as number (%).
NA = not available.
*Data for post-operative mortality were obtained from 13,420 patients in 2019 and 11,890 patients in 2023.
†Post-operative morbidity data were collected from 13,270 patients in 2019 and 12,652 patients in 2023.

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Information on post-operative morbidity was obtained for 12,652 patients (99.2%), among whom 1,937 (15.3%) experienced complications. The incidence of local complications was 9.4%, while systemic complications were observed in 3.5% of patients. The most frequently reported local complication was intra-abdominal fluid collection (1.8%), followed by anastomotic leakage (1.3%), mechanical ileus (1.3%), and wound-related issues (1.2%). The incidence of chyle ascites, reported for the first time in 2023, was 0.3%. For systemic complications, pulmonary issues were the most prevalent, affecting 2.6% of the patients.

DISCUSSION

The Nationwide Gastric Cancer Data Survey, first initiated in 1994, is conducted and analyzed every five years, providing valuable insights into trends and changes in gastric cancer management over time. The 2023 data collection marks the 7th iteration of this survey, continuing its legacy of contributing to the understanding of gastric cancer in Korea. While the survey interval has been reduced to align with the term of the association's executive board, this change also reflects the need to adapt to the rapidly evolving landscape of modern healthcare, where advancements in technology, treatment modalities, and patient management occur at an unprecedented pace. By conducting the survey more frequently, we aim to better recognize and respond to emerging trends in gastric cancer, enabling timely updates to medical policies, treatment strategies, and healthcare practices that align with these changes.

Owing to the ongoing medical crisis in South Korea in 2024, the number of participating institutions in this nationwide survey slightly decreased from 68 hospitals in the previous survey in 2019 to 66 hospitals in this survey. Consequently, the number of surveyed patients also decreased from 14,016 to 12,751. However, this reduction in the total number of surveyed patients in the current survey was mainly caused by the reduction in the total number of gastric cancer surgeries performed in Korea. According to statistics from the Health Insurance Review and Assessment Service open portal, the number of gastric cancer surgery claims decreased from 14,947 cases in 2019 to 14,164 cases in 2023. This trend may be attributed to the widespread implementation of health screening programs in Korea, which has led to an increase in the diagnosis of EGC and a corresponding shift toward ESD over surgical intervention. To capture this recent trend, ESD-related data were added to this survey. Additionally, the survey incorporated new categories related to surgery, reflecting the adoption of innovative surgical techniques and anastomosis methods in clinical practice. Previously ambiguous factors were also refined and subdivided for greater specificity.

One of the key findings of this nationwide survey is the continued increase in the proportion of EGC among all surgically treated patients, as well as the rising proportion of EGC cases (**Table 1**, **Fig. 2**). With the progression toward a super-aged society and the continuing national health screening program, the proportion of EGC is expected to increase further. A significant proportion of EGCs can be treated endoscopically, but there remains a considerable percentage of EGC cases that require surgical intervention [13]. Additionally, as less invasive surgical treatments, such as totally laparoscopic surgery and robotic surgery, become more widely applied in clinical practice, a greater number of elderly patients are likely to become suitable candidates for surgery. According to a multi-center retrospective study in Korea, gastric cancer surgery in elderly patients aged ≥80 years achieves reasonable long-term survival despite the increased risk of severe complications [14]. The current study revealed that the proportion of patients aged 71 years or older was 31.7%, more than a 20%

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increase from the 1995 data. However, evidence remains lacking [15], and further research on the safety of gastric cancer surgery in older adult populations, particularly those aged 75 years and older or 80 years and older, will be essential.

Meanwhile, the proportion of gastric cancer in younger patients has gradually declined during the survey period. The proportion of patients in the young-aged group (under 30 years) has consistently decreased with each survey, showing a total reduction of over 1.5% (from 1.9% in 1995 to 0.3% in 2023). The proportion of patients in the middle-aged group (from 31 to 50 years) also declined by over 9%. This trend is largely attributable to the continued decrease in *Helicobacter pylori* infection rates among younger age groups [16,17]. However, long-term monitoring of trends in young-onset gastric cancer incidence is necessary.

The histologic composition of gastric cancer in 2023 showed some differences compared to 2019, which may reflect evolving diagnostic criteria and reporting practices. The publication of the 5th edition of the WHO tumor classification [18] in late 2019 and the updated standardized pathology report by the Gastrointestinal Pathology Study Group of the Korean Society of Pathologists [19] in early 2023 likely influenced these trends. Notably, the WHO 5th edition clarified the diagnostic criteria for poorly cohesive carcinoma (PCC), distinguishing PCC (not otherwise specified) from PCC (signet ring cell type), which were previously used interchangeably. Although interobserver variability in histologic interpretation remains a challenge, these updates aimed to enhance diagnostic precision and reproducibility. It is anticipated that these efforts will improve consistency in histologic classification and contribute to more reliable clinicopathologic correlations.

The TNM staging results show that while the overall proportion of EGC has remained stable, the proportion of pT1a cases decreased slightly relative to pT1b cases. This shift may be attributed to the increasing application of ESD for small, well-differentiated, and superficially invasive EGCs that meet the ESD criteria. Further insights into the impact of widespread ESD application on pT1 stage distribution could be obtained through a comprehensive analysis of nationwide data on ESD-treated patients with EGC.

The current survey also revealed significant changes in surgical approaches for gastric cancer in Korea. A notable finding was the complete reversal in trends, with open surgery accounting for 80% of cases in 2004, while minimally invasive surgery reached 80.3% in 2023. Among the minimally invasive techniques, laparoscopic surgery has shown a steady annual increase, particularly in the proportion of totally laparoscopic procedures employing intracorporeal anastomosis. This trend may be attributed to better outcomes of minimally invasive surgery reported in studies such as KLASS-02, KLASS-04, and KLASS-05 [20-26] conducted by the Korean Laparoendoscopic Gastrointestinal Surgery Study Group. This pattern is expected to continue.

In Korea's healthcare system, where the National Health Insurance covers most costs for conventional gastric cancer surgeries (open or laparoscopic), leaving patients with only 5% out-of-pocket expenses, the steady growth of robotic surgery, which requires significantly higher costs because of the lack of insurance coverage, provides important insights. Studies highlighting that robotic surgery can effectively reduce intraoperative and post-operative complications [27-30] may partly explain its steady growth. Surgeons taking full control of the camera and assisting can also meet the needs of the healthcare environment, where the number of surgeons and medical staff is declining.

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Regarding the extent of resection, one of the most notable changes was the increase in the proportion of PG to 3.4% in 2023. Given the number of proximally located EGCs and the proportion of PG surgeries, it is likely that many patients suitable for PG will still undergo TG. However, the gradual increase in PG is significant, likely due to ongoing clinical trials and educational workshops in Korea regarding different reconstruction methods to reduce complications such as reflux after PG. While the proportion of double tract anastomosis decreased from 81.2% in 2019 to 51.9% in 2023, there was an increase in various types of esophagogastric anastomosis to prevent reflux, with double flap anastomosis being the most commonly performed, accounting for 18.1% of all PG cases. If the reflux prevention and quality-of-life benefits of these reconstructive methods are further validated by multiple studies [31], the adoption of PG may further increase over time.

Regarding post-operative outcomes, post-operative morbidity and mortality rates were reported for the second time following the 2019 data. In 2019, the post-operative morbidity and mortality rates were 14.5% and 1.0%, respectively, while in 2023, they were 15.3% and 1.0%, respectively. The incidence rates of specific complications were similar between 2019 and 2023. Notably, data on chyle ascites were collected for the first time in 2023 and identified in 0.3% of the patients.

A notable change in the 2023 survey was the inclusion of data regarding patients who underwent pre-operative chemotherapy, as well as detailed adjuvant chemotherapy regimens (TS-1, CapOx), which had not been reported in previous surveys (**Supplementary Table 1**). Pre-operative chemotherapy was categorized into neoadjuvant and palliative chemotherapy (**Table 1**). In South Korea, active screening and curative treatment have traditionally been prioritized, resulting in fewer surgeries following neoadjuvant therapy compared to Western countries. However, with the recent development of chemotherapeutic agents, cases of AGC managed with neoadjuvant therapy are gradually increasing, along with instances of conversion surgery after palliative chemotherapy.

This suggests that while the proportion of AGC has been gradually decreasing compared to EGC, pivotal phase 3 studies such as FLOT4, PRODIGY, and RESOLVE have emphasized the increasing importance of neoadjuvant and perioperative chemotherapy for locally AGC [32-34]. Additionally, conversion surgery may be considered for certain selected patients with good responses to palliative chemotherapy, reflecting its increasing feasibility with advancements in palliative chemotherapy. Among the surveyed patients, 2,677 (21.0%) received standard adjuvant chemotherapy, with TS-1 and capecitabine plus oxaliplatin administered to 40.7% and 59.3% of these patients, respectively. Recent studies have also investigated the addition of immunotherapy in the perioperative setting, with the expectation that advancements in systemic chemotherapy will further improve outcomes for AGC.

The inclusion of information on chemotherapy in this survey provides an opportunity to evaluate the role of chemotherapy in enabling surgical treatment for gastric cancer. As more cases are accumulated, future data may offer insights into the contribution of chemotherapy to conversion surgery and the outcomes of neoadjuvant therapy. The survey results also demonstrate the growing emphasis on multidisciplinary treatment strategies in gastric cancer, moving beyond surgery to personalized, tailored therapies. This shift highlights the increasing recognition of preoperative chemotherapy as part of a multidisciplinary approach to optimize treatment outcomes.

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In conclusion, although the current study did not encompass all gastric cancer surgeries performed in Korea in 2023, the results of the 2023 nationwide survey provide a comprehensive overview of the current status of gastric cancer treatment in Korea. This information will serve as a foundation for future gastric cancer research.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

Survey data

Supplementary Table 2

Details of the tumor-node-metastasis stages according to the American Joint Committee on Cancer classification, 8th edition

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