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Nationwide Survey on Endoscopic Submucosal Dissection for Early Gastric Cancer in Korea: Results From the Korean College of *Helicobacter* and Upper Gastrointestinal Research (KCHUGR) 2023 Survey

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Correspondence to
Kee Don Choi
Department of Gastroenterology, Asan Medical Center, University of Ulsan College of Medicine, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea.
Email: keedonchoi@gmail.com

Jong Yeul Lee
Center for Gastric Cancer, National Cancer Center, 323 Ilsan-ro, Ilsandong-gu, Goyang 10408, Korea.
Email: jylee@ncc.re.kr

*Jae Yong Park and Jeong Hoon Lee contributed equally as co-first authors.

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ORCID iDs
Jae Yong Park
https://orcid.org/0000-0001-6114-8920
Jeong Hoon Lee
https://orcid.org/0000-0002-0778-7585

Jae Yong Park [1,*], Jeong Hoon Lee [2,*], Tae-Se Kim [3], Da Hyun Jung [4], Bong Eun Lee [5], Yonghoon Choi [6], Wan-Sik Lee [7], Young-Il Kim [8], Sun Hyung Kang [9], Hyunsoo Chung [10], Su Jin Kim [11], Joon Sung Kim [12], Donghoon Kang [13], Su Youn Nam [14], Seung Han Kim [15], Hyo-Joon Yang [16], Hyun Lim [17], Jin Lee [18], Seon-Young Park [19], Seung-Woo Lee [20], Sun Moon Kim [21], Sam Ryong Jee [22], Dae Young Cheung [23], Chung Hyun Tae [24], Seokin Kang [25], Sung Chul Park [26], Seung In Seo [27], Cheol Min Shin [6], Kee Don Choi [2], Jong Yeul Lee [8], The Research Management Committee of the Korean College of Helicobacter and Upper Gastrointestinal Research

[1]Division of Gastroenterology, Department of Internal Medicine, Chung-Ang University College of Medicine, Seoul, Korea
[2]Department of Gastroenterology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea
[3]Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
[4]Department of Internal Medicine, Yonsei University College of Medicine, Seoul, Korea
[5]Department of Internal Medicine, Pusan National University School of Medicine, Yangsan, Korea
[6]Department of Internal Medicine, Seoul National University Bundang Hospital, Seongnam, Korea
[7]Department of Internal Medicine, Chonnam Medical University Hwasun Hospital, Hwasun, Korea
[8]Center for Gastric Cancer, National Cancer Center, Goyang, Korea
[9]Department of Internal Medicine, Chungnam National University College of Medicine, Daejeon, Korea
[10]Department of Internal Medicine and Liver Research Institute, Seoul National University College of Medicine, Seoul, Korea
[11]Department of Internal Medicine, Pusan National University Yangsan Hospital, Pusan National University School of Medicine, Yangsan, Korea
[12]Department of Internal Medicine, Incheon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[13]Department of Internal medicine, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[14]Department of Internal Medicine, Kyungpook National University Chilgok Hospital, School of Medicine, Kyungpook National University, Daegu, Korea
[15]Department of Internal Medicine, Korea University Guro Hospital, Korea University College of Medicine, Seoul, Korea
[16]Division of Gastroenterology, Department of Internal Medicine and Gastrointestinal Cancer Center, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Korea
[17]Department of Gastroenterology, Hallym University Sacred Heart Hospital, College of Medicine, Hallym University, Anyang, Korea
[18]Division of Gastroenterology, Department of Internal Medicine, Inje University Haeundae Paik Hospital, Inje University College of Medicine, Busan, Korea
[19]Department of Internal Medicine, Chonnam National University Medical School, Gwangju, Korea

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Tae-Se Kim
https://orcid.org/0000-0003-3950-4516
Da Hyun Jung
https://orcid.org/0000-0001-6668-3113
Bong Eun Lee
https://orcid.org/0000-0003-2734-2134
Yonghoon Choi
https://orcid.org/0000-0002-1331-969X
Wan-Sik Lee
https://orcid.org/0000-0002-8021-6228
Young-Il Kim
https://orcid.org/0000-0002-2614-3419
Sun Hyung Kang
https://orcid.org/0000-0002-1913-4346
Hyunsoo Chung
https://orcid.org/0000-0001-5159-357X
Su Jin Kim
https://orcid.org/0000-0003-3816-9664
Joon Sung Kim
https://orcid.org/0000-0001-9158-1012
Donghoon Kang
https://orcid.org/0000-0002-7278-2174
Su Youn Nam
https://orcid.org/0000-0002-5568-7714
Seung Han Kim
https://orcid.org/0000-0001-9247-9175
Hyo-Joon Yang
https://orcid.org/0000-0002-0265-672X
Hyun Lim
https://orcid.org/0000-0001-6581-6420
Jin Lee
https://orcid.org/0000-0003-2404-385X
Seon-Young Park
https://orcid.org/0000-0002-0962-5977
Seung-Woo Lee
https://orcid.org/0000-0002-8985-5499
Sun Moon Kim
https://orcid.org/0000-0002-0436-3381
Sam Ryong Jee
https://orcid.org/0000-0002-7928-1153
Dae Young Cheung
https://orcid.org/0000-0003-4150-3555
Chung Hyun Tae
https://orcid.org/0000-0002-0764-7793
Seokin Kang
https://orcid.org/0000-0003-2228-6479
Sung Chul Park
https://orcid.org/0000-0003-3215-6838
Seung In Seo
https://orcid.org/0000-0003-4417-0135
Cheol Min Shin
https://orcid.org/0000-0003-2265-9845
Kee Don Choi
https://orcid.org/0000-0002-2517-4109
Jong Yeul Lee
https://orcid.org/0000-0001-8709-5097

[20]Division of Gastroenterology, Department of Internal Medicine, Daejeon St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[21]Department of Internal Medicine, Konyang University College of Medicine, Daejeon, Korea
[22]Department of Internal Medicine, Inje University Busan Paik Hospital, Inje University College of Medicine, Busan, Korea
[23]Department of Internal Medicine, Yeouido St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea
[24]Department of Internal Medicine, Ewha Womans University College of Medicine, Seoul, Korea
[25]Department of Internal Medicine, Ilsan Paik Hospital, Inje University College of Medicine, Goyang, Korea
[26]Department of Internal Medicine, Kangwon National University College of Medicine, Chuncheon, Korea
[27]Department of Internal Medicine, Kangdong Sacred Heart Hospital, Hallym University College of Medicine, Seoul, Korea

ABSTRACT

Purpose: Endoscopic submucosal dissection (ESD) has become a standard minimally invasive treatment for selected patients with early gastric cancer (EGC). This study presents the first nationwide survey of patients with EGC treated with ESD in 2023, conducted by the Korean College of *Helicobacter* and Upper Gastrointestinal Research.
Materials and Methods: Data were retrospectively collected from participating referral centers across Korea using a standardized case report form covering patient characteristics, tumor features, procedural details, histopathological findings, and clinical outcomes. Descriptive and comparative analyses were conducted to summarize nationwide ESD practice patterns and outcomes.
Results: Data from 5,460 ESD cases from 5,250 patients across 27 institutions were analyzed. The mean age was 67.4 years, with 74.1% males. Multiple synchronous lesions were identified in 3.7%. Most lesions were located in the lower third of the stomach (64.0%), and differentiated-type adenocarcinomas accounted for 87.8%. The en bloc and complete resection rates were 99.2% and 91.4%, respectively. Curative resection was achieved in 80.5%, whereas local non-curative resection (L-NCR) and surgical non-curative resection (S-NCR) were identified in 2.8% and 16.7%, respectively. Additional surgery was performed more frequently in patients with S-NCR than in those with L-NCR (59.3% vs. 24.7%). The bleeding and perforation rates were 3.6% and 0.9%, respectively, and were mostly managed conservatively or endoscopically. The median length of hospitalization was 4.0 days.
Conclusions: This first nationwide survey provides a comprehensive overview of the current practice of EGC treatment using ESD in Korea, demonstrating high technical success and safety, and establishing a baseline dataset for future longitudinal research.

Keywords: Gastric cancer; Endoscopic submucosal dissection; Multicenter study; Korea

INTRODUCTION

Gastric cancer remains a leading malignancy in Korea; however, the widespread implementation of national screening programs has markedly increased early-stage disease detection [1,2]. Consequently, endoscopic resection, particularly endoscopic submucosal dissection (ESD), has emerged as a curative treatment option for early gastric cancer (EGC) meeting the established indication, offering organ preservation and excellent long-term outcomes comparable to surgery in appropriately selected cases [3-6].

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Conflict of Interest
Young-Il Kim and Hyunsoo Chung, contributing editors of the *Journal of Gastric Cancer*, were not involved in the editorial evaluation or decision to publish this article. All remaining authors have declared no conflicts of interest.

Author Contributions
Conceptualization: C.K.D., L.J.Y.; Data curation: P.J.Y., L.J.H., K.T.S., J.D.H., L.B.E., C.Y., L.W.S., K.Y.I., K.S.H.[1], C.H., K.S.J., K.D., N.S.Y., K.S.H.[2], Y.H.J., L.H., L.J., P.S.Y., L.S.W., K.S.M., J.S.R., C.D.Y., T.C.H., K.S., P.S.C., S.S.I., S.C.M., C.K.D., L.J.Y.; Formal analysis: P.J.Y.; Funding acquisition: P.J.Y.; Investigation: P.J.Y., L.J.H., K.T.S., J.D.H., L.B.E., C.Y., L.W.S., K.Y.I., K.S.H.[1], C.H., K.S.J., K.D., N.S.Y., K.S.H.[2], Y.H.J., L.H., L.J., P.S.Y., L.S.W., K.S.M., J.S.R., C.D.Y., T.C.H., K.S., P.S.C., S.S.I., S.C.M., C.K.D., L.J.Y.; Methodology: P.J.Y., K.Y.I., L.H., K.S., S.C.M., C.K.D., L.J.Y.; Project administration: C.K.D., L.J.Y.; Resources: P.J.Y., L.J.H., K.T.S., J.D.H., L.B.E., C.Y., L.W.S., K.Y.I., K.S.H.[1], C.H., K.S.J., K.D., N.S.Y., K.S.H.[2], Y.H.J., L.H., L.J., P.S.Y., L.S.W., K.S.M., J.S.R., C.D.Y., T.C.H., K.S., P.S.C., S.S.I., S.C.M., C.K.D., L.J.Y.; Software: P.J.Y.; Supervision: C.K.D., L.J.Y.; Validation: P.J.Y., K.Y.I., L.H., K.S., S.C.M., C.K.D.; Visualization: P.J.Y.; Writing - original draft: P.J.Y.; Writing - review & editing: P.J.Y., L.J.H., K.T.S., J.D.H., L.B.E., C.Y., L.W.S., K.Y.I., K.S.H.[1], C.H., K.S.J., K.D., N.S.Y., K.S.H.[2], Y.H.J., L.H., L.J., P.S.Y., L.S.W., K.S.M., J.S.R., C.D.Y., T.C.H., K.S., P.S.C., S.S.I., S.C.M., C.K.D., L.J.Y.

K.S.H.[1], Sun Hyung Kang; K.S.H.[2], Seung Han Kim.

The number of ESD procedures performed for gastric neoplasia has steadily increased nationwide over the past decade [7]. ESD has numerous advantages, including minimal invasiveness, rapid recovery, and the ability to achieve en bloc resection, making it particularly suitable for older patients or those with comorbidities who may be suboptimal candidates for surgery [8-10]. With the ongoing demographic transition toward an aging society, the clinical and public health need for ESD continues to increase.

While the Korean Gastric Cancer Association (KGCA) has conducted periodic nationwide surveys of surgically treated gastric cancer since 1995 [11,12], no analogous investigation has been performed for endoscopic treatment. Considering the increasing use of ESD as a frontline curative modality for EGC, a comprehensive nationwide evaluation of current practice patterns and outcomes is essential. Therefore, the Korean College of *Helicobacter* and Upper Gastrointestinal Research (KCHUGR) has undertaken this first nationwide data collection project to characterize the current nationwide landscape of ESD practice for EGC.

In conducting this nationwide survey, we aimed to characterize the real-world practice patterns and short-term outcomes of ESD for EGC in Korea in 2023, providing a national benchmark for quality assurance and future comparative analyses with surgical and international datasets.

MATERIALS AND METHODS

Study design and participating centers

This nationwide, multicenter survey was conducted by the KCHUGR Research Management Committee to collect real-world data on patients with EGC treated with ESD in 2023. To achieve nationwide representation, invitations were sent to the principal investigators at major institutions performing gastric ESD across Korea. A total of 27 institutions participated, comprising predominantly university-affiliated hospitals and one specialized referral center. Each institution designated a representative ESD operator responsible for data submission. Data were collected using a standardized case report form (CRF) developed to ensure uniformity and completeness. The data collection period extended from November 2024 to November 2025. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Boards of all participating institutions (including Chung-Ang University Hospital; approval No. 2410-011-19545). The requirement for informed consent was waived because anonymized retrospective data were used in this study.

Study population

Eligible patients were those who underwent gastric ESD at the participating institutions in 2023 and were pathologically diagnosed with EGC. Only patients with adenocarcinoma were included in this study. Patients with neuroendocrine tumors as the predominant pathology were excluded, as were patients with missing or erroneous clinical or pathological data. When multiple gastric cancer lesions were identified within 1 year of the study period, they were considered synchronous lesions.

Data collection and variables

The CRF captured comprehensive information on patient demographics, hospitalization, procedural details, lesion characteristics, histopathological findings, and short-term

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outcomes (**Supplementary Table 1**). The patient-level variables included sex, age, height, weight, length of hospital stay, and date of ESD. Age stratification was based on clinical relevance and commonly used thresholds in prior ESD studies, with an age cutoff of 80 years [9,13-15]. Body mass index (BMI) categories were defined according to the Korean Society for the Study of Obesity guidelines [16]. Procedural variables included procedure completion status, en bloc resection, and periprocedural complications. Subsequent management data included whether additional gastrectomy was performed and its indication. Lesion-specific variables included the number of gastric cancer lesions and their anatomical locations. Macroscopic morphology was classified according to standard endoscopic criteria [17]. Histopathological variables included histologic types, tumor size (long-axis diameter) measured on the resected specimen, invasion depth, submucosal invasion depth when applicable, lymphovascular invasion, and horizontal and vertical margin status.

Histological assessment and clinical outcome definitions

Histological classification was based on the World Health Organization Classification of Digestive System Tumors, 5th edition [18,19]. Pathological staging followed the eighth edition of the American Joint Committee on Cancer tumor–node–metastasis system [20]. Curability was assessed according to the Korean Society of Gastrointestinal Endoscopy and KGCA guidelines, incorporating histologic differentiation, tumor size, invasion depth, lymphovascular involvement, and resection margin status.

En bloc resection was defined as resection of the tumor in a single piece without visible residual lesions, in accordance with the standardized pathology reporting system used in Korea [21]. Complete resection was defined as resection of a tumor with histologically negative horizontal and vertical margins (HM0 and VM0). Curative resection (CR) was defined as en bloc resection fulfilling all of the following conditions: HM0 and VM0; absence of lymphovascular invasion (Ly0/V0); and meeting one of the absolute or expanded criteria [3,5], namely (1) differentiated-type mucosal cancer of any size without ulceration, (2) differentiated-type mucosal cancer ≤3 cm with ulceration, (3) differentiated-type cancer ≤3 cm with minute submucosal invasion (≤500 μm), or (4) undifferentiated-type mucosal cancer ≤2 cm without ulceration.

In this study, non-curative resections (NCRs) were categorized into local non-curative resection (L-NCR) and surgical non-curative resection (S-NCR) based on the necessity of additional surgery. L-NCR was defined as failure of en bloc resection or presence of positive or indeterminate horizontal margins (HM+) in differentiated-type adenocarcinoma, despite fulfilling all other criteria for CR. S-NCR was defined as failure to meet the CR criteria owing to pathological risk factors associated with lymph node metastasis, including lymphovascular invasion (Ly1/V1) or positive/indeterminate vertical margins (VM1), for which additional gastrectomy was strongly recommended.

This nomenclature was adopted to provide a more intuitive clinical distinction between cases requiring only local management and those requiring surgical intervention, rather than relying on purely pathological numbering. These categories correspond to the eCura classification system [4], with CR encompassing eCura A and B, L-NCR corresponding to eCura C1, and S-NCR corresponding to eCura C2. In the eCura classification system, eCura A represents lesions confined to the mucosa that satisfy the CR criteria and are associated with a negligible risk of lymph node metastasis, whereas eCura B refers to differentiated-type cancers with minute submucosal invasion that carry an acceptably low risk and do not require

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additional surgery. In this study, these categories corresponded to CR criteria (1), (2), and (4) for eCura A, and criterion (3) for eCura B. For analyses applying the eCura classification, the submucosal invasion depth was assessed using the same cutoff (≤500 μm) that was defined in the Korean guidelines [3,5] and used consistently throughout the study. Analyses were primarily conducted on a lesion-based level; when multiple lesions were resected during a single session, each lesion was analyzed separately for curability outcomes.

For curability analysis, histologic differentiation was defined as follows: papillary adenocarcinoma and well- or moderately differentiated tubular adenocarcinomas were classified as differentiated type, whereas poorly differentiated tubular adenocarcinoma and poorly cohesive carcinoma/signet-ring cell carcinoma were classified as undifferentiated type [3]. Rare histologic subtypes (e.g., gastric carcinoma with lymphoid stroma, fundic gland–type adenocarcinoma, mucinous adenocarcinoma, hepatoid adenocarcinoma, and micropapillary adenocarcinoma) were excluded from the curability analysis because they fall outside the standard curative criteria in current guidelines [3,5].

Complications included intraprocedural bleeding requiring transfusion; delayed bleeding, defined as overt gastrointestinal bleeding, a ≥2 g/dL decrease in hemoglobin, or the need for transfusion; perforation; and other procedure-related adverse events. Adverse events and additional surgery were analyzed on a per-hospitalization basis, with multiple ESDs performed during a single hospitalization considered as one ESD session.

Data quality control

All variables were predefined using detailed operational definitions to minimize inter-institutional variability. The submitted data were reviewed for completeness, accuracy, and consistency. Queries were sent to participating institutions to resolve missing or discrepant entries before final data consolidation. After final validation, the anonymized data were merged into a master dataset.

Statistical analysis

Descriptive statistics were used to summarize the clinicopathological and procedural characteristics. Continuous variables are presented as means ± standard deviations, and categorical variables as numbers and percentages. Hospital stay is presented as median with interquartile range (IQR) due to its skewed distribution. Categorical variables were compared using the χ^2 test. Subsequently, to account for potential within-institution correlation inherent in our multicenter data, generalized estimating equations (GEEs) with a logit link function were used to compare categorical outcomes between groups, specifically for histology-specific S-NCR rates, age-stratified NCR rates (<80 vs. ≥80 years), and the frequency of additional surgery. We specified the participating institution as the clustering variable and employed an exchangeable working correlation structure.

To further elucidate the clinical implications of our classification system, we compared the clinicopathological characteristics of the CR, L-NCR, and S-NCR groups. For these analyses, pairwise comparisons between the CR group and each NCR group (L-NCR and S-NCR) were performed using Student's t test or Mann–Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables. To maintain a family-wise error rate of 0.05, a Bonferroni correction was applied, and a P-value of <0.025 (0.05/2) was considered statistically significant for these pairwise comparisons.

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Additionally, to assess potential differences in clinical outcomes based on institutional volume, institutions were categorized into 2 groups using the median number of cumulative ESD cases during the study period (cutoff: 144 cases): high-volume centers (HVCs, n=13; range, 144–962) and low-volume centers (LVCs, n=14; range, 8–115). Differences in key procedural outcomes, including en bloc resection, CR, and procedure-related adverse events, between the 2 groups were evaluated using the same GEE framework to account for institutional clustering. In all other analyses, a 2-sided P-value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (version 19.0; IBM Corp., Armonk, NY, USA).

RESULTS

Participating institutions and case volume

A total of 27 hospitals participated, contributing data on 5,492 ESD procedures performed on 5,280 patients with histologically confirmed EGC in 2023. After excluding cases with neuroendocrine tumors or missing or erroneous data, 5,460 ESD cases from 5,250 patients were included in the final analysis (**Fig. 1**). The annual ESD case volume exceeded 500 procedures in 2 institutions, ranged from 100 to 499 in 13 institutions, and was less than 100 in 12 institutions. A total of 123 endoscopists performed ESD, with substantial inter-institutional variation in the number of operators (range, 1–9).

Patient characteristics

The baseline patient characteristics are summarized in **Table 1**. The mean age was 67.4 years, and 1,325 patients (25.2%) were aged ≥75 years (**Fig. 2A**). Males accounted for 74.1% of the study cohort. The mean BMI was 24.6 kg/m^2. Single lesions were observed in 97.2% of the patients, whereas synchronous multiple lesions were identified in 3.7%, with a maximum of 4 lesions per patient.

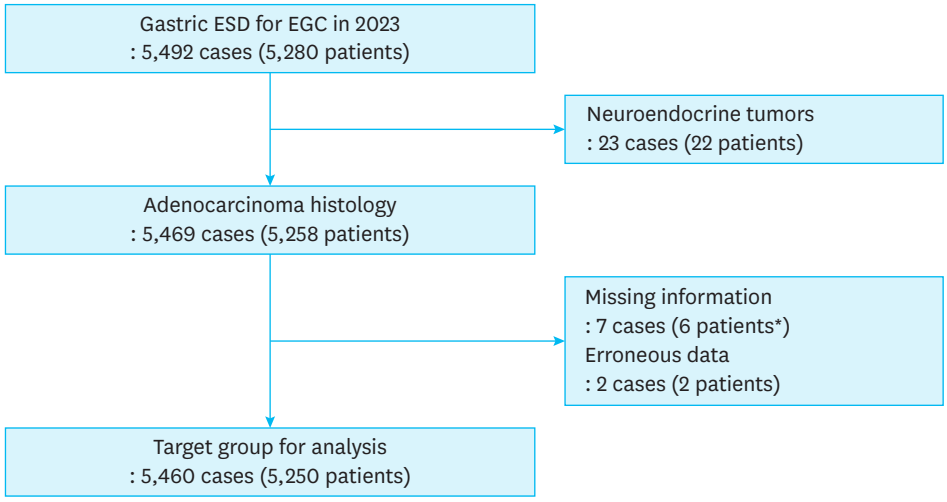

Fig. 1. Flow diagram of case and patient selection. Eligible patients were those who underwent gastric ESD at participating institutions in 2023 and were pathologically diagnosed with EGC. Only cases with adenocarcinoma histology were included. Cases with neuroendocrine tumors as the predominant pathology were excluded. Additional exclusions were applied due to missing information or erroneous data. Case and patient numbers differ because some patients underwent ESD for multiple lesions.
ESD = endoscopic submucosal dissection; EGC = early gastric cancer.
*One patient with 2 synchronous lesions had only one lesion excluded due to missing information; the patient remained in the study population because the other lesion had complete data and was included in the analysis.

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Table 1. Baseline clinical characteristics of enrolled patients (n=5,250)

Characteristics	Overall
Age (yr)	67.4±9.9
Male sex	3,892 (74.1)
BMI (kg/m²)	24.6±3.3
BMI classification	
Underweight (<18.5 kg/m²)	138 (2.6)
Normal weight (18.5–22.9 kg/m²)	1,501 (28.6)
Overweight (23.0–24.9 kg/m²)	1,423 (27.1)
Obese	
Class I obesity (25.0–29.9 kg/m²)	1,891 (36.0)
Class II obesity (30.0–34.9 kg/m²)	269 (5.1)
Class III obesity (≥35.0 kg/m²)	28 (0.5)
Patients with synchronous lesions*	196 (3.7)

Values are shown as the mean ± standard deviation or number (%). Data are presented on a patient basis. Each patient was counted once regardless of the number of lesions or procedures.
BMI = body mass index.
*Among patients with synchronous lesions, the number of lesions was 2 in 182 patients, 3 in 11 patients, and 4 in 3 patients.

Lesion characteristics

ESD was discontinued in 6 cases due to technical difficulties or procedure-related complications (including non-lifting due to severe submucosal fibrosis, uncontrolled bleeding, or suspected perforation). All of these cases were managed with conversion to surgery. Subsequent analyses were limited to successfully resected lesions (5,454 cases). As shown in **Table 2**, most lesions were located in the lower third of the stomach (64.0%), followed by the middle (25.6%), and upper thirds (10.4%). The mean pathological tumor size (long-axis diameter) was 1.7 cm (**Fig. 2B**). The most common macroscopic type was type 0–IIc (36.0%). Differentiated-type adenocarcinomas accounted for 87.8% of the lesions, whereas undifferentiated-type adenocarcinomas accounted for 10.9%. Rare histological subtypes accounted for 1.4% of the cases. Intramucosal cancers were observed in 83.4% of the cases, whereas superficial and deep submucosal invasions were identified in 8.0% and 8.7% of the cases, respectively.

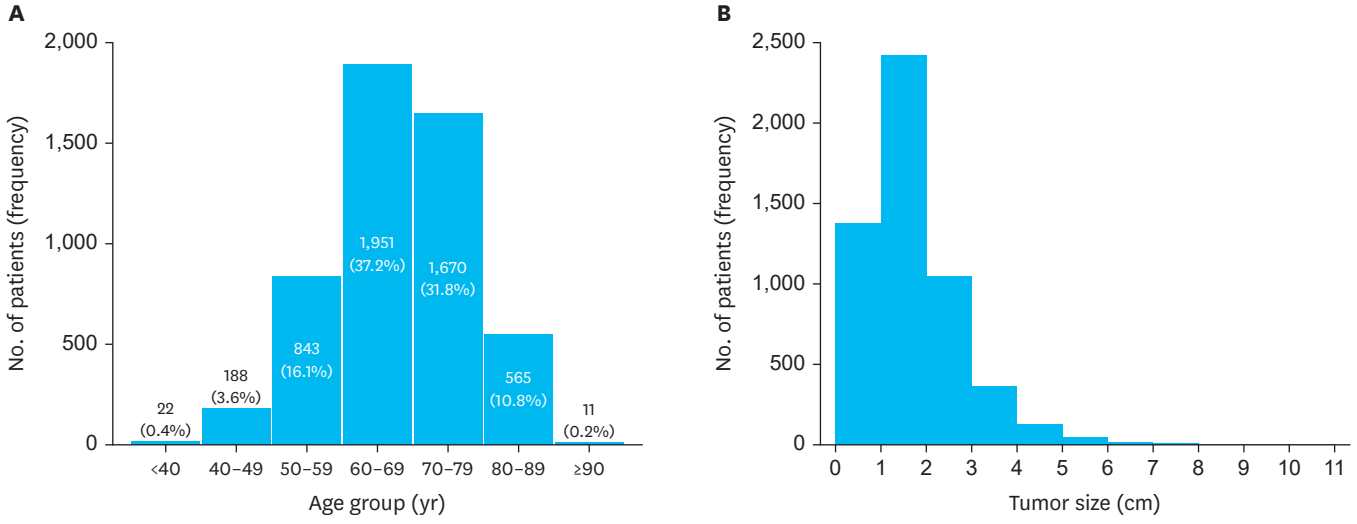

Fig. 2. Distributions of age and tumor size. (A) Age distribution of the study population (n=5,250 patients). Data are presented in 10-year intervals with the number and percentage of patients indicated above each bar. (B) Histogram showing the distribution of tumor size (n=5,454 cases), presented in 1-cm intervals.

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Table 2. Macroscopic and histopathologic characteristics of early gastric cancer lesions (n=5,454)

Variable	Overall
Endoscopic tumor size (cm)	1.9±1.0
Location	
Upper third	565 (10.4)
Middle third	1,396 (25.6)
Lower third	3,489 (64.0)
Remnant stomach	4 (0.1)
Macroscopic type	
I	110 (2.0)
IIa	1,068 (19.6)
IIb	1,005 (18.4)
IIc	1,966 (36.0)
III	22 (0.4)
Mixed type*	1,283 (23.5)
Pathologic tumor size (cm)	1.7±1.1
Histology	
Papillary adenocarcinoma	39 (0.7)
Tubular adenocarcinoma (WD)	2,833 (51.9)
Tubular adenocarcinoma (MD)	1,914 (35.1)
Tubular adenocarcinoma (PD)	207 (3.8)
PCC and/or SRC	381 (7.0)
Other rare histologic types	80 (1.5)
Depth of invasion	
Lamina propria	2,649 (48.6)
Muscularis mucosa	1,897 (34.8)
Superficial submucosa (≤500 μm)†	436 (8.0)
Deep submucosa (>500 μm)	472 (8.7)
Lymphovascular invasion	
Absent	5,079 (93.1)
Present	375 (6.9)

Values are shown as the mean ± standard deviation or number (%). Data are presented on a lesion basis. Patients with multiple gastric lesions were included in the analysis more than once. Six lesions in which endoscopic submucosal dissection was discontinued due to technical difficulty or procedure-related complications (non-lifting, n=4; uncontrolled bleeding, n=1; suspected perforation, n=1) were excluded from this table. All of these 6 lesions subsequently underwent surgical management. These cases were included in the analysis of procedure-related adverse events but excluded from lesion-based curability analyses. Tumor size represents the maximum diameter (long axis) measured during endoscopy or on the resected specimen.
WD = well-differentiated; MD = moderately differentiated; PD = poorly differentiated; PCC = poorly cohesive carcinoma; SRC = signet ring cell carcinoma.
*Mixed type indicates lesions with multiple macroscopic features (e.g., IIa+IIc, IIb+IIc).
†Submucosal invasion depth was measured from the muscularis mucosa to the deepest point of tumor invasion (cutoff: ≤500 μm, Korean guidelines).

Procedural outcomes

Among resected lesions, the en bloc resection and complete resection rates were 99.2% and 91.4%, respectively. After excluding lesions with rare histological types (n=80), CR was achieved in 80.5% of the cases, while L-NCR and S-NCR occurred in 2.8% and 16.7% of the cases, respectively (**Table 3**). An institutional-level summary of the key outcomes is presented in **Supplementary Table 2**.

Compared with the CR group, the S-NCR group was characterized by a significantly higher proportion of patients aged ≥80 years (14.5% vs. 10.3%, P<0.001), larger tumor size (mean, 2.4 vs. 1.5 cm, P<0.001), and a higher prevalence of undifferentiated histology (31.1% vs. 7.1%, P<0.001; **Supplementary Table 3**). Similarly, compared with the CR group, the L-NCR group showed a larger tumor size (mean, 2.7 vs. 1.5 cm, P<0.001) and were more frequently located in the upper or middle thirds of the stomach (P=0.002).

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Table 3. Curability assessment according to guideline-based criteria (n=5,374)

Curability status	Values
CR	4,325 (80.5)
eCura A	4,076 (75.8)
eCura B	249 (4.6)
L-NCR (eCura C-1)	150 (2.8)
S-NCR (eCura C-2)	899 (16.7)

Values are shown as number (%). Data are presented on a lesion basis. Each lesion was evaluated separately for curability, and patients with multiple gastric lesions were included in the analysis more than once. Rare histologic subtypes (e.g., gastric carcinoma with lymphoid stroma, fundic gland–type adenocarcinoma, mucinous adenocarcinoma, hepatoid adenocarcinoma, and micropapillary adenocarcinoma) were excluded from the curability analysis.
Components may not sum to totals due to rounding.
CR = curative resection; L-NCR = local non-curative resection; S-NCR = surgical non-curative resection.

The proportion of S-NCR was substantially higher in undifferentiated-type lesions than in differentiated-type lesions (47.6% [280/588] vs. 12.9% [619/4,786], P<0.001). After adjusting for institutional clustering using GEE, undifferentiated histology was independently associated with a higher likelihood of S-NCR (adjusted odds ratio [aOR], 6.01; 95% confidence interval [CI], 4.28–8.42; P<0.001). When stratified by an age cutoff of 80 years, the NCR rate was significantly higher in the older group (≥80 years) than in the younger group (25.3% vs. 18.8%, P<0.001). This association remained significant in the GEE model, with the older group showing a higher likelihood of NCR (aOR, 1.50; 95% CI, 1.28–1.74; P<0.001).

Management of NCR and adverse events

Regarding clinical management after NCR, additional surgery was performed more frequently in patients with S-NCR than in those with L-NCR (59.3% vs. 24.7%, P<0.001). After adjusting for institutional clustering using GEE, patients with S-NCR had a significantly higher likelihood of undergoing additional surgery than those with L-NCR (aOR, 4.09; 95% CI, 2.77–6.05; P<0.001).

Among the 899 patients with S-NCR, 533 (59.3%) underwent additional surgery, while 366 (40.7%) received non-surgical management, including endoscopic re-treatment or close observation. Patients in the additional surgery group were significantly younger (mean, 65.7 vs. 69.7 years, P<0.001) and less likely to be aged ≥80 years (8.1% vs. 23.8%, P<0.001) than those in the non-surgical management group (**Supplementary Table 4**).

Among the 5,269 ESD sessions, procedure-related adverse events occurred in 240 patients (4.6%) (**Table 4**). Adverse events and additional surgeries were reported on a per-hospitalization basis. Intraprocedural or delayed bleeding occurred in 3.6% of the cases, and perforation occurred in 0.9%. When comparing patients with and without adverse events, the proportion of older patients (≥80 years) did not differ significantly (P=0.731). However, the adverse event group was characterized by a significantly higher proportion of lesions ≥20 mm (37.5% vs. 30.2%, P=0.016) and a higher prevalence of tumors located in the upper or middle thirds of the stomach (P<0.001). Surgical intervention for ESD-related complications was required in only 5 cases, whereas the majority of adverse events were managed conservatively or endoscopically. Additional surgery was performed in 614 cases (11.7%), mostly because of NCR (599/614, 97.6%). The median length of hospital stay was 4.0 days (IQR, 4.0–4.4).

Impact of institutional volume on procedural success and safety

To evaluate the potential variability among institutions, we compared the clinical outcomes between HVCs and LVCs (categorized by the median annual volume of 144 cases). The en

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Table 4. Additional surgery and procedure-related adverse events (n=5,269)

Events	Values
Adverse events	240 (4.6)
Intraprocedural bleeding*	8 (0.2)
Delayed bleeding†	181 (3.4)
Perforation	46 (0.9)
Others	5 (0.1)
Additional surgery (indication)	614 (11.7)
NCR	599 (11.4)
Complication	5 (0.1)
Others‡	10 (0.2)

Values are shown as number (%). Data are presented on a per-hospitalization basis, with multiple ESDs during a single hospitalization considered as one ESD session. Percentages were calculated based on the total number of ESD sessions (n=5,269).
NCR = non-curative resection; ESD = endoscopic submucosal dissection.
*Intraprocedural bleeding was defined as an event requiring transfusion.
†Delayed bleeding was defined as overt gastrointestinal bleeding, a decrease in hemoglobin of ≥2 g/dL, or the need for transfusion.
‡Additional surgery was performed in 9 patients classified as curative resection according to guideline-based criteria, based on cautious clinical judgment after discussion with the patient. These included lesions that met the expanded criteria but had potentially unfavorable features, including predominantly undifferentiated histology despite a size of ≤2 cm, lesions >2 cm with a minor undifferentiated component, or shallow submucosal invasion. One patient underwent surgery due to patient preference.

bloc resection rates were 99.5% and 97.8% in the HVCs and LVCs, respectively. Although the difference was statistically significant (aOR, 0.20; 95% CI, 0.07–0.60; P=0.004), both groups achieved high success rates exceeding 97%. Furthermore, there were no significant differences in the rate of CR (80.7% in HVCs vs. 79.0% in LVCs; aOR, 0.91; 95% CI, 0.63–1.31; P=0.606) and the rate of procedure-related adverse events (4.5% in HVCs vs. 4.6% in LVCs; aOR, 1.02; 95% CI, 0.54–1.93; P=0.941) according to institutional volume.

DISCUSSION

This nationwide multicenter survey provides a comprehensive overview of the real-world practice patterns and outcomes of ESD for EGC in Korea. With the steadily increasing detection of EGC, driven by nationwide gastric cancer screening programs, the number of ESD procedures continues to increase, and it is estimated that a substantial proportion of gastric cancers are now treated endoscopically [7,12]. In this context, the present survey offers an important and timely overview of contemporary ESD practices at the national level.

This study highlights several key findings with important clinical implications. First, the en bloc and complete resection rates were high and comparable to those reported in previous large-scale domestic and international studies, underscoring the technical maturity and standardization of ESD practices in Korea [22,23]. Second, the CR rates were consistent with prior institutional and multicenter cohorts, despite the inclusion of a broad spectrum of real-world cases [23-25]. Third, major procedure-related complications were uncommon, with only a very small proportion of patients requiring surgical intervention, highlighting the overall safety profile of ESD in routine clinical practice.

Beyond the overall technical success, a more detailed examination of curability provides important insights into the clinical role of ESD. Although CR was achieved in 80.5% of the cases, NCR remained unavoidable in a subset of patients. L-NCR constituted only a small fraction of the overall cohort (2.8%) and generally represented lesions with minimal

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oncological risk that may be managed without immediate surgery but rather with additional endoscopic treatment or careful surveillance. Conversely, S-NCR accounted for 16.7% of the cases, largely driven by pathological risk factors for lymph node metastasis, underscoring the complementary diagnostic role of ESD in informing subsequent treatment decisions.

Notably, ESD serves not only as a therapeutic modality but also as a pathology-based diagnostic tool that enables detailed histopathological assessment. Unlike gastrectomy with lymph node dissection, ESD is inherently limited to the resection of the mucosa and submucosa, and microscopic lymphovascular invasion or margin involvement may only be identified after resection. Accordingly, NCR rates after ESD are expected to be numerically higher than those observed after primary surgical treatment, reflecting differences in procedural scope rather than technical inadequacy [26,27]. This distinction underscores the importance of interpreting CR and NCR rates within the procedural and oncological context of ESD rather than as a direct surrogate for technical failure.

The higher NCR rate observed in older patients further highlights the need for individualized treatment strategies. Notably, technical outcomes and margin status were largely comparable between the older and non-older patients, suggesting that the higher NCR rate in the older patients is not primarily driven by technical failure or inadequate endoscopic assessment. Rather, in very old patients with limited physiological reserve or substantial comorbidities, ESD may be preferentially selected, even for borderline lesions within or near the expanded criteria, as a less invasive, pathology-guided approach than upfront gastrectomy. Reflecting this clinical context, there is an emerging movement, particularly in Japan, to expand the indications for ESD and the criteria for CR in older patients [28]. Consequently, a higher NCR rate in this population may reflect a deliberate clinical trade-off, accepting potential non-curativity to avoid the morbidity of primary surgical resection.

This clinical context is further evidenced by the substantial proportion of patients with S-NCR in our study who did not undergo additional surgery (approximately 40%). This finding likely reflects real-world clinical decision-making in which patient age, comorbidities, patient preferences (including refusal of surgery or transfer to another hospital), and individualized risk assessment are carefully weighed against the potential benefits of surgery. As ESD is increasingly being performed to older patients with multiple comorbidities, clinical decision-making must balance the risk of lymph node metastasis against procedural morbidity and overall life expectancy. In selected patients with limited physiological reserve, less invasive approaches or close surveillance may be reasonable alternatives after NCR, based on detailed pathological risk stratification.

The post-procedural outcomes in this survey further support the safety of ESD, with an overall incidence of procedure-related adverse events of less than 5%. The rates of delayed bleeding and perforation were very low and most adverse events were successfully managed with conservative or endoscopic treatment, consistent with previous reports from high-quality ESD series [9,29]. The short duration of hospitalization observed in this cohort is consistent with the minimally invasive nature of ESD and contrasts favorably with surgical management, reinforcing its role as a standard treatment option for appropriately selected patients with EGC [10].

In our study, the institutional volume was associated with a statistically significant difference in the en bloc resection rate (99.5% vs. 97.8%). However, this absolute difference of only

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1.7% likely reached statistical significance owing to the large sample size of our multicenter cohort. Importantly, even the LVCs achieved an en bloc resection rate of 97.8%, which is comparable to the results reported in previous HVC-based studies. Furthermore, when considering that both the CR rate and procedure-related adverse events showed no significant differences between the 2 groups, our findings suggest that key procedural outcomes and peri-procedural management of gastric ESD have reached a level of "upward standardization" across Korea. Although subtle variations in resection rates exist, essential clinical efficacy and safety are consistently maintained regardless of institutional volume. However, considering the descriptive nature of this study, these results should be interpreted as reflecting overall practice patterns rather than establishing a causal volume–outcome relationship.

Compared with surgically treated cohorts reported in prior nationwide surveys by the KGCA, patients undergoing ESD tended to be older (mean age, 67.4 vs. 64.6 years) and to harbor smaller, more differentiated tumors [12]. This finding reflects the selective application of ESD in accordance with established guideline criteria and supports the complementary roles of endoscopic and surgical treatment in the multidisciplinary management of gastric cancer [3-5,30].

Korea has one of the highest incidences of gastric cancer worldwide, yet it continues to achieve excellent treatment outcomes [31,32]. The widespread implementation of organized screening programs, early detection, and high-quality endoscopic and surgical expertise are likely major contributing factors. In this regard, the incorporation of nationwide ESD data along with existing surgical datasets represents an important advance in accurately capturing the current landscape of gastric cancer treatment in Korea. This dataset provides a valuable baseline for nationwide follow-up surveys and longitudinal assessments.

This study had several limitations. First, although this was a nationwide survey, not all institutions performing gastric ESD were included, and the participating centers were predominantly tertiary and high-volume hospitals. Consequently, these findings may not fully represent the national practice patterns, particularly in low-volume or community-based settings. Based on indirect estimates from recent comprehensive nationwide claims-based studies and the National Quality Assessment of Gastric Cancer Care by the Health Insurance Review and Assessment Service, the present study is estimated to have captured approximately 40%–50% of gastric ESD procedures for EGC performed nationwide during the study period [33,34]. Nevertheless, considering that gastric ESD in Korea is largely concentrated in experienced HVCs, the participating institutions are likely to reflect contemporary standard practice. Second, as this was a cross-sectional survey, long-term outcomes such as recurrence and survival could not be assessed. Third, ulcer status, which may affect the curability classification, was not systematically collected in this study. Ulcer presence was recorded only when explicitly documented by the investigators, and lesions without a clear description of ulceration were conservatively classified as nonulcerative; this approach may have led to misclassifications in the curability assessment. Future surveys should incorporate standardized ulcer assessments to enable more refined analyses.

In conclusion, this 2023 nationwide survey is the first comprehensive assessment of ESD for EGC in Korea. The findings confirm that ESD has high technical success rates, favorable CR rates, and low complication rates in real-world clinical practice. Continued nationwide data collection, together with existing surgical datasets, will help establish a more complete

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national framework for gastric cancer treatment and provide a robust foundation for quality improvement initiatives and longitudinal monitoring.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1
Case report form variables collected in the nationwide ESD survey

Supplementary Table 2
Institutional-level summaries of key outcomes

Supplementary Table 3
Clinicopathological characteristics according to curability groups (n=5,374)

Supplementary Table 4
Comparison of clinical characteristics between the additional surgery and non-surgical management groups among patients with surgical non-curative resection (n=899)

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