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Operation sequence of bidirectional endoscopy with topical anesthesia affected colonoscopy performance: a randomized controlled trial

Qing Wang[1†], Yue Sui[2,4†], Jingwen Gong[1] and Xing Chen[2,3*]

Abstract

Background The operation sequence of bidirectional endoscopy with topical anesthesia varies among endoscopists, which interferes with clinical procedure. The study aimed to investigate the influence of different operation sequences on the outcomes of quality indicators and improve bidirectional endoscopy performance.

Methods A randomized trial was conducted at the affiliated hospital of a medical university in China. Outpatients who initially underwent bidirectional endoscopy with topical anesthesia were enrolled. Eligible patients were randomized to either the colonoscopy-first group or the esophagogastroduodenoscopy-first group. Dyclonine hydrochloride mucilage and oxybuprocaine hydrochloride gel were administered for topical anesthesia. After finishing the previous process, the subsequent one was performed immediately. Quality indicators of esophagogastroduodenoscopy and colonoscopy were compared between the groups.

Results Analyzing 395 combined procedures, the cecal intubation rate, discomfort score during esophagogastroduodenoscopy, examination score of esophagogastroduodenoscopy, and colorectal polyp detection rate were similar between the two groups. The colonoscopy-first group had lower colonic spasm incidence (66.0% vs. 30.3%, $p < 0.001$), shorter median cecal intubation time (254 s vs. 211 s, $p < 0.001$), and higher colonoscopy comfort rate (72.5% vs. 85.6%, $p < 0.001$) compared with the esophagogastroduodenoscopy-first group. Operation sequence significantly affected the incidence of colonic spasm (OR 4.739, 95%CI 3.054–7.352, $p = 0.000$), which correlated with cecal intubation time ($r = 0.196$, $p < 0.001$) and patient discomfort score ($r = 0.136$, $p = 0.007$).

Conclusion In bidirectional endoscopy with topical anesthesia, performing colonoscopy first may improve colonoscopy performance without affecting esophagogastroduodenoscopy examination. The study was registered prior to conducting the research in the Chinese Clinical Trial Registry (https://www.chictr.org.cn) on November 7, 2023 with the trial identification number ChiCTR2300077408.

Keywords Bidirectional endoscopy, Colonic spasm, Endoscopic performance, Topical anesthesia

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Introduction

Same-day bidirectional endoscopy (BDE) refers to a combination of esophagogastroduodenoscopy (EGD) and colonoscopy, which is commonly performed to evaluate gastrointestinal conditions such as gastrointestinal bleeding, iron-deficiency anemia, abdominal pain, and cancer screening [1, 2]. EGD and colonoscopy can be performed either with or without sedation [3]. Benzodiazepines, opioids, and propofol are commonly used in sedated endoscopy, accompanied by risks of circulatory and respiratory depression, drug allergies etc. EGD followed by colonoscopy is accepted as the most beneficial sequence in BDE with moderate and deep sedation, which requires lower doses of sedatives, faster recovery, less cardiovascular stress, lower incidence of adverse events, and better patient tolerability [4–6]. Notwithstanding the growing popularity of sedated endoscopy, topical anesthesia remains as an approach of critical importance in clinical settings, particularly for patients who are at high risk of sedation-related adverse events or those with contraindications to anesthetic medications. It also shortens the recovery time, requires lower cost, and eliminates the need for an escort. Unlike sedated BDE, the operation sequence of BDE with topical anesthesia varies among endoscopists, which confuses the patients and reduces work efficiency, especially in large endoscopy centers with heavy workloads.

The gag reflex, panic, fear, bloating and a large amount of inflation in the gastric cavity during EGD, reflexively cause increased peristalsis of the colon [7]. As a result, the operator tends to overinflate and push through the spasmodic intestinal lumen, causing discomfort to the patient, raising technical difficulties, and extending insertion and inspection time [8, 9]. To assess whether the performance of BDE with topical anesthesia is significantly affected by variation in the order of operations, we conducted this randomized controlled study, providing relevant insights for clinical decision-making.

Materials and methods

Study population

Outpatients who initially underwent BDE examination under topical anesthesia at the First Affiliated Hospital of Shanxi Medical University between November 2023 and February 2024 were enrolled. Patients with one or more of the following conditions were excluded: older than 75 years, previous gastrectomy or colectomy, polyposis, incomplete colonoscopy due to obstruction, inadequate bowel preparation, gastric retention, emergency endoscopy, colonoscope withdrawal time of less than six min, and refusal to participate in the study. Age, sex, height, weight, diabetes mellitus, colorectal cancer history of first-degree relatives, and personal history of abdominal or pelvic surgery were recorded. All examinations were performed by three senior endoscopists with more than ten years of experience. They have been trained in a standardized manner of performing digestive endoscopy by the academic leader, following the same protocol for the examinations. The study was conducted in accordance with the Declaration of Helsinki, adhered to the Consort guidelines, and approved by the Institutional Review Board (NO. KYLL-2023–217). Written informed consents were obtained from all participants involved in the study. The study was registered prior to conducting the research in the Chinese Clinical Trial Registry (https://www.chictr.org.cn) with the trial identification number ChiCTR2300077408.

An independent biostatistician, not involved in data collection or analysis, generated a random number table with an allocation ratio of 1:1 using SPSS software (version 27.0). Eligible participants were enrolled in the study and randomized to the colonoscopy-first group encoded as "1", or EGD-first group encoded as "2" when making an appointment with nurses in the endoscopy center. Allocation results were kept by research assistants, and the engaged endoscopists and patients were informed of the operation sequence at the beginning of the examination.

BDE procedure

Patients underwent bowel preparation with a split oral 3 L polyethylene glycol electrolyte powder solution. One bottle of 10 ml dyclonine hydrochloride mucilage (0.1 g/10 ml, Yangtze River Pharmaceutical Group Co., LTD, China) was administered 10 min before EGD. Patients were instructed to keep it in their throats for five minutes to achieve oropharyngeal topical anesthesia, after which they were to swallow it. Prior to inserting the colonoscope, one 10 ml tube of oxybuprocaine hydrochloride gel (30 mg/10 ml, manufactured by Shenyang Oasis Pharmaceutical Co., Ltd., China) was applied to the surface of the anus. No analgesic or anti-spasmodic medications were given before or during the procedure. Examinations were conducted using gastroscopes (UHD-GT300, AQ-300, AOHUA, China) and colonoscopes (UHD-CL300I, AQ-300, AOHUA, China) without any auxiliary device, such as transparent cap.

The patients in the colonoscopy-first group underwent colonoscopy followed by EGD, while the patients in the EGD-first group underwent EGD followed by colonoscopy. Once the previous procedure finished, the subsequent one began immediately. When colonic spasm occurred, the endoscopist would attempt to gently manipulate the endoscope to relieve the pressure on the colonic wall, or wait for a short period to allow the spasm to subside naturally. An assistant's abdominal press was applied when necessary. The cecum was identified by

the endoscopic landmarks of the ileocecal valve and the appendiceal orifice. A colonoscopy was deemed successful only when the tip of the scope was able to reach the base of the cecum. Patients took dynamic position changes during colonoscope withdrawal according to our conventional method: supine position for the cecum, ascending colon, hepatic flexure (left lateral position when necessary) and transverse colon; right lateral position (or 30° to the right) for the splenic flexure and descending colon; left lateral position for the sigmoid colon and rectum [10, 11]. Biopsy and polypectomy for polyps < 8 mm in diameter were performed during withdrawal without contraindications. No complicated therapy was performed in outpatient services, such as polypectomy for polyps > 8 mm in diameter and endoscopic submucosal dissection.

Bowel preparation quality was rated by endoscopists using the Boston Bowel Preparation Scale (BBPS). The EGD photo documentation was scored using an artificial intelligence (AI) system (digestive endoscopy-assisted quality control software, Shanghai AOHUA Endoscopy Co., Ltd.) in real time. The software has obtained Shanghai Medical Device Registration Approval No. 20242210463. It automatically captured images of anatomical structures and lesions on a separate screen, evaluating 31 locations of the upper gastrointestinal tract with a full score of 100 points. Additionally, the AI system was used to record the amount of time spent in EGD, cecal intubation, and colonoscope withdrawal. The degrees of patient discomfort during EGD and colonoscopy were evaluated according to the Modified Gloucester Comfort Scale (MGCS). In the case of immediate discomfort reported by patients during the procedure, the endoscopist would first assess the severity of the discomfort. For mild discomfort, the endoscopist would verbally reassure the patient and adjust the endoscope's position or the speed of advancement to minimize the discomfort. If the discomfort was moderate, a short break in the procedure would be taken. If the patient claimed unbearable discomfort, the procedure would be terminated and appropriate medical interventions would be initiated. The reasons for the incomplete examination would be carefully documented. After the procedure, patients were monitored for delayed adverse events. Patients were asked to report any new or worsening symptoms, such as abdominal pain, nausea, vomiting, or bleeding. They were also scheduled for a follow-up phone call within seven days after the procedure to specifically inquire about any delayed adverse events.

Throughout the whole colonoscopy process, a trained research assistant closely observed the changes in the intestinal lumen on the endoscope screen. Whenever the characteristics of the intestinal lumen met the following criteria, it was recorded as a case of significant colonic spasm. MGCS score, procedure-related adverse events, and detection of colorectal polyps were also recorded by the assistants.

Definition

Referring to one study by Nemoto et al. [12], we defined significant colonic spasm as a luminal opening less than two-thirds of the maximum diameter at any colon segment, lasting over three seconds. The MGCS score was evaluated on a scale of 1 to 5 (1 = no discomfort; 2 = very slight discomfort; 3 = mild discomfort; 4 = moderate discomfort; 5 = extreme discomfort). Scores of 1–3 were considered to indicate comfort, and scores of 4 and 5 were considered to indicate significant discomfort [13]. A total BBPS score of less than six points or any segmental score less than two points was considered to be insufficient bowel preparation [14]. Polyp detection rate (PDR) was calculated as the proportion of patients with at least one polyp detected, with the exception of hyperplastic polyps smaller than 5 mm diagnosed by white light imaging or electronic staining in the rectum, because there is substantial evidence that such polyps in the distal colon are not precancerous [15, 16]. Colonoscope withdrawal time was defined as the time for the removal of the colonoscope from the cecum to the anus, excluding the time needed for biopsy and polypectomy. According to the Guidelines for the Prevention and Control of Overweight and Obesity in Chinese Adults, a BMI of ≥ 28.0 kg/m^2 is considered obese.

The primary outcome was the incidence of significant colonic spasm. The secondary outcomes were the MGCS scores during EGD and colonoscopy, cecal intubation time, PDR, and AI score on EGD.

Statistical analysis

SPSS 27.0. was used for the data analysis. Exploratory data analysis and Shapiro–Wilk tests were performed to assess the normality of the data distribution. Normally distributed continuous data were expressed as the mean ± standard deviation and compared using Student's t-test. Non-normally distributed continuous data were expressed as median (M) and interquartile range (IQR), and compared using the Mann–Whitney U test. Categorical variables were presented as counts and percentages, and compared using the Pearson chi-square test. A binary logistic regression analysis was performed to identify the risk factors for colonic spasm, and each odds ratio (OR) was calculated with a 95% confidence interval (CI). Correlation analysis was performed using the Spearman's correlation analysis. Statistical significance was set at $p < 0.05$, and all tests were two-sided.

The sample size was calculated on the basis of our clinical experience. We assumed that the colonic spasm rate would be 45% and 65% in the colonoscopy-first and EGD-first groups, respectively. The sample size required for our study was estimated on $\alpha = 0.05$,1-$\beta = 0.90$. Approximately 128 patients were required in each group (256 in total) to satisfy these requirements.

Results

Baseline characteristics

A total of 440 eligible patients were initially enrolled in this study, of which 45 were excluded from the analysis because of inadequate bowel preparation ($n = 39$), incomplete colonoscopy with CRC obstruction ($n = 2$), gastric retention ($n = 2$), and refusal to undergo the examination due to gastroscope initial insertion failure ($n = 2$). 395 patients were eventually analyzed, including 195 in the colonoscopy-first group and 200 in the EGD-first group (Fig. 1). As shown in Table 1, there were no significant differences in median age, colonoscopy withdrawal time, BBPS score, sex, obesity, diabetes mellitus, CRC history of first-degree relatives, and personal history of abdominal or pelvic surgery between the two groups.

AI scores on EGD examination in the two groups were similar

As shown in Table 2, there was no significant difference in the median AI score on EGD examination between the two groups (91 vs. 90 points, $p = 0.16$).

Colonoscopy performed better in colonoscopy-first group

The cecal intubation rate was 100% in each group. As shown in Table 3, the incidence of significant colonic spasms was lower in the colonoscopy-first group than in the EGD-first group (30.3% vs. 66.0%, $p < 0.001$), and the median cecal intubation time was shorter in the colonoscopy-first group than in the EGD-first group (211 s vs. 254 s, $p < 0.001$). There was no significant difference in the PDR between the two groups (65.1% vs. 60.0%, $p = 0.29$).

A multivariate logistic regression analysis was carried out to further identify the factors influencing significant colonic spasm. As presented in Table 4, the operation sequence and sex emerged as independent risk factors. Specifically, the risk of significant colonic spasm was 4.739-fold higher when EGD was performed before colonoscopy (odds ratio [OR] 4.739, 95% confidence interval [CI] 3.054–7.352, $P = 0.000$). Moreover, females had a 1.687-fold increased risk of colonic spasm compared with males (OR 1.687, 95% CI 1.087–2.618, $P = 0.02$).

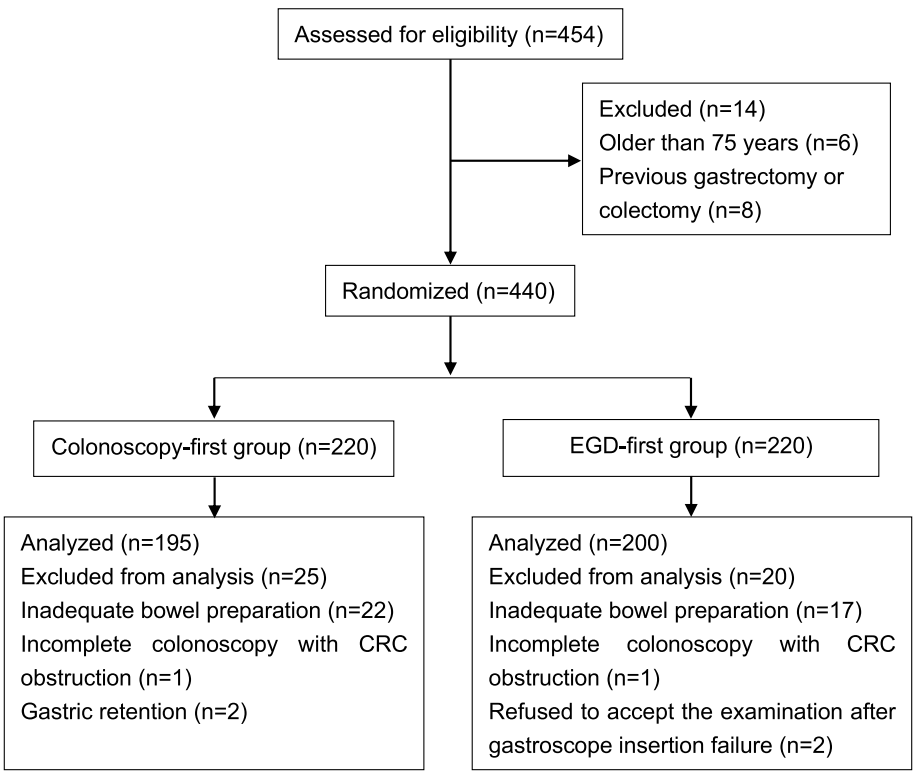

Fig. 1 Participant flow diagram. EGD, esophagogastroduodenoscopy; CRC, colorectal cancer

Table 1 Baseline characteristics

	Colonoscopy-first group($n=195$)	EGD-first group ($n=200$)	Z/χ^2	*p*
Age (year)	57.0 (14)	55.0 (17)	-1.394	0.163
Sex, n (%)			0.747	0.387
Male	90 (46.2%)	101 (50.5%)		
Female	105 (53.8%)	99 (49.5%)		
Obesity, n (%)	14 (7.2%)	13 (6.5%)	0.072	0.789
Diabetes mellitus, n (%)	13 (6.7%)	20 (10.0%)	1.433	0.231
History of abdominal or pelvic surgery, n (%)	14 (7.2%)	11 (5.5%)	0.470	0.493
CRC history of first degree relative, n (%)	9 (4.6%)	10 (5.0%)	0.032	0.858
Withdrawal time (s)	435.0 (65)	423.5 (66)	-0.661	0.509
BBPS	8.0 (2)	8.0 (2)	-1.573	0.116

EGD esophagogastroduodenoscopy, *CRC* colorectal cancer, *BBPS* Boston Bowel Preparation Scale

Age, withdrawal time and BBPS are expressed as median (inter-quartile range) and compared using Mann–Whitney U test

Table 2 Artificial intelligence scores on esophagogastroduodenoscopy examination

	Colonoscopy-first group($n=195$)	EGD-first group($n=200$)	Z	*p*
AI score	91.0 (5)	90.0 (6)	-10.419	0.16

AI, artificial intelligence; EGD, esophagogastroduodenoscopy. The AI score is expressed as median (interquartile range) and compared using the Mann–Whitney U test

Table 3 Quality indicators of colonoscopy

	Colonoscopy-first group ($n=195$)	EGD-first group ($n=200$)	χ^2/Z	*p*
Colonic spasm, n (%)	59(30.3%)	132(66.0%)	50.512	< 0.001
Cecal intubation time (s)	211.0(117)	254.0(71)	-5.760	< 0.001
PDR	65.1%	60.0%	1.108	0.29

EGD esophagogastroduodenoscopy, *PDR* polyp detection rate. Insertion time was expressed as median (interquartile range) and compared using the Mann–Whitney U test

Table 4 Multivariate logistic analysis of influencing factors for colonic spasm

Variable	OR	95%CI	*p*
Operation sequence			
Colonoscopy first	1	-	-
EGD first	4.739	3.054–7.352	0.000
Sex			
Male	1	-	-
Female	1.687	1.087–2.618	0.02
Age	1.006	0.987–1.024	0.54
Overweight	1.153	0.290–4.590	0.84
Diabetes mellitus	0.970	0.276–3.405	0.96
History of abdominal or pelvic surgery	1.413	0.579–3.445	0.45
BBPS	1.278	0.981–1.664	0.07

EGD esophagogastroduodenoscopy, *BBPS* Boston Bowel Preparation Scale, *OR* odds ratio, *CI* confidence interval. Both age and BBPS were treated as continuous variables and the other variables were binary

Patient discomfort was improved in colonoscopy-first group

The MGCS scores recorded during EGD and colonoscopy for both groups are presented in Table 5. The median MGCS scores of EGD were similar between the two groups (4.0 vs. 4.0, $p=0.97$), whereas the median MGCS score of colonoscopy was lower in the colonoscopy-first group than in the EGD-first group (2 vs. 3, $p<0.001$). The comfort rate of colonoscopy was higher in the colonoscopy-first group than that in the EGD-first group (85.6% vs. 72.5%, $p<0.001$).

Table 5 Modified Gloucester Comfort Scale of each procedure

	Colonoscopy-first group ($n=195$)	EGD-first group ($n=200$)	Z	*p*
MGCS of EGD	4.0(2)	4.0(2)	-0.041	0.97
MGCS of colonoscopy	2.0(1)	3.0(1)	-9.289	< 0.001

MGCS Modified Gloucester Comfort Scale (1 = no discomfort; 2 = very slight discomfort; 3 = mild discomfort; 4 = moderate discomfort; and 5 = extreme discomfort). Scores of 1–3 were considered to indicate comfort and scores of 4 and 5 were considered to indicate significant discomfort. The MGCS score was expressed as median (interquartile range) and compared using the Mann–Whitney U test. *EGD* esophagogastroduodenoscopy.

According to Spearman's correlation analysis, cecal intubation time and MGCS score were positively correlated with colonic spasm (r = 0.196, $p < 0.001$; r = 0.136, $p = 0.007$).

Discussion

BDE with topical anesthesia can begin with either EGD or colonoscopy, and there is no consensus on the optimal test sequence yet. Our study found that the colonoscopy performance was affected by the test sequence in BDE with topical anesthesia, and might improve when performed prior to EGD.

Colonoscopy is currently considered the gold standard for diagnosing colorectal diseases [17], but the potential of colonoscopy can only be realized if the procedure is completed safely, with good visualization of the mucosa and adequate patient compliance. In the present study, the incidence of colonic spasm was higher when EGD was performed prior to colonoscopy. Besides the gag reflex, panic, fear, bloating and a large amount of inflation in the gastric cavity during EGD reflexively causing increased peristalsis of the colon [7], the psychological state of the patient can also play a role. Colonoscopy is often perceived as a more invasive and uncomfortable procedure compared to EGD. Stress and anxiety are known to increase the activity of the sympathetic nervous system, which can cause colonic smooth muscle contraction. This might be the reason why females had a 1.687-fold increased risk of colonic spasm compared with males in the present study. By getting the more daunting procedure out of the way first, patients may experience a sense of relief. This psychological shift could lead to a relaxation of the colonic muscles. Additionally, patients may be more mentally prepared for the colonoscopy at the start of the procedure, as they have not yet experienced the discomfort of an EGD, which could contribute to a more relaxed physiological state and fewer spasms.

Colonic spasms may cause significant delays in colonoscopy. When the colon muscles contract involuntarily, it becomes more difficult for the endoscopist to navigate the endoscope through the colon. This often requires additional time to carefully maneuver around the spasming areas, increasing the overall duration of the procedure. Lee et al. [18] reported consuming warm water before unsedated colonoscopy reduced procedure-related pain and technical difficulties. In their study, the ileal intubation time was significantly shorter for the warm water group than for the cold water group and no extra water group. We believe that this might be partially explained by the relief effect of warm water on colonic spasms. In the present study, the cecal intubation time was longer in the EGD-first group. However, another randomized controlled study including 80 patients showed that cecal intubation time, total procedure time, and prolonged insertion ratio did not differ between different procedure sequences in unsedated BDE. But it has to be pointed out that they administered 25 mg of meperidine and 20 mg of scopolamine-N-butylbromide as standard premedication, and the duration effect of analgesic and anti-spasmodic premedication was disregarded [19]. Although butyl-scopolamine and glucagon were reported to be used intravenously for the prevention of peristalsis [20], they are seldom utilized in routine endoscopic examinations in China.

Spasms can cause discomfort or even pain during the procedure, and prolonged procedure time put additional stress on the patient which further exacerbates the spasms and make the procedure more challenging for both the patient and the endoscopist. Our results showed that the comfort rate during colonoscopy was lower in the EGD-first group. This negative experience may not only affect the patient's cooperation during the procedure but also have long-term implications. For cancer screening, which often requires regular surveillance, patients who experience significant discomfort are more likely to be reluctant to undergo follow-up procedures, potentially leading to delayed diagnosis and less favorable treatment outcomes.

The constriction of the colonic lumen during a spasm can cause the mucosal folds to bunch up or distort, making it harder for the endoscopist to clearly visualize the inner lining of the colon. As a result, polyps, which are often small and may be hidden within the folds of the mucosa, are more likely to be missed. Moreover, the increased difficulty in maneuvering the endoscope during a spasm can disrupt the systematic inspection of the colon. In addition, the time-consuming nature of dealing with spasms can reduce the amount of time available for a thorough examination of the colon. However, in this study, the difference in PDR was not significant between the two groups (65.1% vs. 60.0%, $p = 0.29$), which may be attributed to the small sample size. In the future, a tandem colonoscopy study with larger sample size could be carried out to compare the adenoma miss rate.

In terms of EGD, no significant difference in the degree of patient discomfort was observed in this study. However, Cho et al. [19] demonstrated that EGD was perceived to be more stressful when colonoscopy was performed first, according to the results from patient questionnaires. Choi et al. [20] came up with the same result as Cho's by analyzing patient questionnaires as well. We suppose that recall bias might be a confounding factor for analyzing results depending on patient questionnaires. Even suffered from both procedures, the memory of the latter may be more impressive. Instead of using questionnaire, we asked trained research assistants

to record the patient discomfort score according to MGCS during each procedure in real time. Moreover, Cho and Choi posited that prior colonoscopy and subsequent bowel distension further exacerbated abdominal discomfort incurred during EGD. However, it should be noted that antispasmodic drugs were employed as standard pre-medications in their studies, and room air was utilized for insufflation, contributing to more severe bowel distension subsequent to colonoscopy. While in the present study, no antispasmodic medications were administered either before or during the procedure. Consequently, we surmise that the bowel distension was less intense and thus less likely to induce discomfort during EGD compared to the situation in their studies.

Complete observation and photo documentation are important measures in the quality control of EGD, and the minimum requirement for photo documentation varies worldwide [21, 22]. In the past, EGD quality control, especially related to photo documentation, could only be performed manually by endoscopic experts. Cho et al. [19] reported significantly superior quality for retroflexion-related steps, visualization of the angular fold, and general assessment of the stomach and upper gastrointestinal tract when EGD was performed before colonoscopy. In their study, all EGD procedures were recorded on videotape, and the quality of the 18 EGD steps was assessed by three endoscopists. The advancement of emerging technologies like AI suggests that automated quality audits and feedback could offer promising solutions and outcomes [23]. Several studies have demonstrated that AI can accurately identify anatomical locations in EGD images while maintaining strict quality control [24, 25]. Our findings showed no significant difference in AI scoring for EGD examination between the two groups. Different evaluation methods may explain the discrepancies between the outcomes.

Adults over 75 years old were excluded from this study because of their higher risk of adverse events with colonoscopy, regardless of the indication [26, 27], which may be a confounder of procedure-related adverse event evaluation. A total of 440 participants were finally included in this study, which was higher than the calculated sample size. This variance was primarily due to two key considerations. Firstly, this approach was driven by the need to adapt to the real-world challenges of data collection and to safeguard the integrity and statistical power of our study. As the recruitment process unfolded, we recognized that the real-world context presented a more complex scenario, such as patient dropout during the study and incomplete data recording. Secondly, we expected to detect some relatively small but clinically significant differences. A larger sample size can more stably present the differences and reduce the interference of random fluctuations on the results, making the research results more generalizable and reliable.

There are several limitations to the nature of endoscopic studies. First, there is no official scoring system for the assessment of colonic spasm. By combining the simple and practical assessment of colonic spasm in a study published by Nemoto et al. [12] with our practical experience, we established the definition of significant colonic spasm in the present study. Second, this was an open-label study. As in most similar studies on gastrointestinal endoscope operation, lack of double-blindness was inevitable [2, 4]. However, we used AI-measured or third-party observed indicators to control bias. Third, all procedures were conducted by experienced endoscopists; therefore, such a conclusion might not be applicable to trainee endoscopists. Their immature endoscopic operation skill might lead both EGD and colonoscopy to be much more stressful to patients, and during colonoscopy, they usually take longer to reach the cecum. A lengthier procedure is both likely to heighten patient discomfort and increase the incidence of colonic spasms. In addition, this study was conducted in a tertiary hospital with a high-volume endoscopy unit. In different settings, there may be differences in the quality and type of endoscopic equipment, moreover, the support staff and the overall workflow may differ, which can impact the procedure. Fourth, the assessment of colonic spasm was carried out by a single trained research assistant. This approach potentially introduced bias, and multiple observers' assessment should be included to mitigate such biases in future research. Finally, because the endoscopic AI system has not been widely used in China, this study was conducted in only one university hospital. Further validation in multicenter clinical trials is required.

Conclusions

Within the context of bidirectional endoscopy under topical anesthesia, the performance of colonoscopy was found to be affected by the test sequence. Performing colonoscopy before EGD led to a diminished incidence of colonic spasm, a shorter cecal intubation time, and enhanced patient tolerance during colonoscopy, while not impeding the performance of EGD.

Abbreviations

AI	Artificial intelligence
BBPS	Boston Bowel Preparation Scale
BDE	Bidirectional endoscopy
CRC	Colorectal cancer
CI	Confidence interval
EGD	Esophagogastroduodenoscopy
MGCS	Modified Gloucester Comfort Scale
IQR	Interquartile range
OR	Odds ratio
PDR	Polyp detection rate

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Authors' contributions
C.X. contributed to the study conception and design, and revising the manuscript; W.Q. and S.Y. contributed to the acquisition, analysis, interpretation of data, and drafting of the article; G.J. contributed to drafting of the article. All authors reviewed the manuscript.

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Data availability
Data that support the findings of this study have been deposited in the Science Data Bank repository, https://www.scidb.cn/en/anonymous/ZmlpVUp2.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of the First Hospital of Shanxi Medical University (NO. KYLL-2023–217). Informed consent was obtained from all subjects involved in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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References

1. Urquhart J, Eisen G, Faigel DO, et al. A closer look at same-day bidirectional endoscopy. Gastrointest Endosc. 2009;69:271–7.
2. Passisd L, Subhanudh T, Sakolwan S, et al. Optimal sequences of the same-visit bidirectional endoscopy: a systematic review and meta-analysis. Dig Endosc. 2020;32:706–14.
3. Dossa F, Megetto O, Yakubu M, et al. Sedation practices for routine gastrointestinal endoscopy: a systematic review of recommendations. BMC Gastroenterol. 2021;21:22.
4. Choi GJ, Oh HC, Seong HK, et al. Comparison of procedural sequence in same-day bidirectional endoscopy: a systematic review and meta-analysis. Korean J Intern Med. 2020;35:331–41.
5. Hsieh YH, Lin HJ, Tseng KC. Which should go first during same-day bidirectional endosocopy with propofol sedation? J Gastroenterol Hepatol. 2011;26:1559–64.
6. Carter D, Lahat A, Papageorgiou NP, et al. Comparison of procedural sequence in same-day consecutive bidirectional endoscopy using moderate sedation a prospective randomized study. J Clin Gastroenterol. 2014;48:236–40.
7. Ali MK, Liu L, Chen JH, et al. Optimizing autonomic function analysis via heart rate variability associated with motor activity of the human colon. Front Physiol. 2021;12:619722.
8. Chen BL, Ma YY, Zhong CL, et al. Suppression effect and safety of acupuncture on colonic spasm during colonoscopy: a randomized controlled trial. J Gastrointest Oncol. 2022;13:1169–77.
9. Chen X. Premedication in colonoscopy examination. In: Chen X, editor. One man method and the technique for colonoscope. 2nd ed. Shanghai: Shanghai Science and Technology Press; 2015. p. 18.
10. Sui Y, Wang Q, Chen HH, et al. Comparison of adenoma detection in different colorectal segments between deep-sedated and unsedated colonoscopy. Sci Rep. 2022;12(1):15356.
11. Sui Y, Chen X, Ma T, et al. Comparison of three sedation models for same-day painless bidirectional endoscopy A multicenter randomized controlled trial. J Gastroenterol Hepatol. 2022;37(8):1603–9.
12. Daiki N, Sho S, Hideki M, et al. Inhibitory effect of lidocaine on colonic spasm during colonoscopy: a multicenter double-blind, randomized controlled trial. Dig Endosc. 2019;31:173–9.
13. Balla AJ, Reesd CJ, Corfeb BM, et al. Sedation practice and comfort during colonoscopy: lessons learnt from a national screening programme. Eur J Gastroenterol Hepatol. 2015;27:741–6.
14. Apichet S, Pallop S, Kanokpoj C, et al. Bowel preparation using 2-L split-dose polyethylene glycol regimen plus lubiprostone versus 4-L split-dose polyethylene glycol regimen: a randomized controlled trial. BMC Gastroenterol. 2022;22:424.
15. Amano T, Nishida T, Shimakoshi H, et al. Number of polyps detected is a useful indicator of quality of clinical colonoscopy. Endosc Int Open. 2018;6:E878–84.
16 Rex DK. Key quality indicators in colonoscopy. Gastroenterol Rep. 2023;11:goad009.
17. Sung JJY, Ng SC, Chan FKL, et al. An updated Asia pacific consensus recommendations on colorectal cancer screening. Gut. 2015;64:121–32.
18. Lee H, Kim JY, Rhee PL, et al. Effectiveness of warm water consumption to reduce patient discomfort during colonoscopy: a randomized controlled trial. Am J Gastroenterol. 2009;104:2935–41.
19. Cho JH, Kim JH, Lee YC, et al. Comparison of procedural sequences in same-day bidirectional endoscopy without benzodiazepine and propofol sedation: starting at the bottom or the top. J Gastroenterol Hepatol. 2010;25:899–904.
20. Choi JS, Youn YH, Lee SK, et al. Which should go first during same-day upper and lower gastrointestinal endoscopy? A randomized prospective study focusing on colonoscopy performance. Surg Endosc. 2013;27:2209–15.
21. Vincenzo DF, Saverio A, Arnaldo A, et al. Quality performance measures in upper gastrointestinal endoscopy for lesion detection: Italian AIGO-SIED-SIGE joint position statement. Dig Liver Dis. 2022;54:1479–85.
22. Kim SY, Park JM. Quality indicators in esophagogastroduodenoscopy. Clin Endosc. 2022;55:319–31.
23. Tonozuka R, Niikura R, Itoi T. Artificial intelligence for routine esophagogastroduodenoscopy quality monitoring: Is the future right before our eyes? Gastrointest Endosc. 2022;95:1147–9.
24. Choi SJ, Khan MA, Choi HS, et al. Development of artificial intelligence system for quality control of photo documentation in esophagogastroduodenoscopy. Surg Endosc. 2022;36:57–65.
25. Zhang LH, Yao LW, Lu ZH, et al. Current status of quality control in screening esophagogastroduodenoscopy and the emerging role of artificial intelligence. Dig Endosc. 2024;36:5–15.
26. Joseph GN, Heidarnejad F, and Sherer EA. Evaluating the cost-effective use of follow-up colonoscopy based on screening findings and age. Comput Math Methods Med. 2019;2019:2476565. https://doi.org/10.1155/2019/2476565.
27. Calderwood AH, Tosteson TD, Walter LC, et al. Colonoscopy utilization and outcomes in older adults: data from the New Hampshire Colonoscopy Registry. J Am Geriatr Soc. 2022;70:801–11.

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