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Retrospective Study

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AIMS AND SCOPE

The primary aim of World Journal of Gastrointestinal Endoscopy (WJGE, World J Gastrointest Endosc) is to provide scholars and readers from various fields of gastrointestinal endoscopy with a platform to publish high-quality basic and clinical research articles and communicate their research findings online.

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EDITORIAL

Revisiting malignant gastric outlet obstruction: Where do we stand?

Krishna Kumar Govindarajan

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Abstract

The scope of management of malignant gastric outlet obstruction is everexpanding. The therapeutic use of endoscopy is gaining popularity not just owing to its technical advancement and satisfactory patient outcomes. With technical success rates close to 96%, stent placement for palliating gastric obstruction has ensured a median survival of about 2 months post-deployment of gastroduodenal stents. Understanding the correct concept of palliation is the need of the hour in management. Identifying the right patient for palliation, selecting the appropriate intervention and auditing the outcome are vital in delivering optimal care. Also, newer procedures such as endoscopic gastro-enterostomy offer promising outcomes in palliative care.

Key Words: Gastric outlet obstruction; Stent; Endoscopy; Palliation; Malnutrition

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Core Tip: Decision on management of malignant gastric outlet obstruction needs to take into account the questions-why, when and how. The endoscopic management requires to be tailored to the patients' needs to provide the optimal palliation.

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INTRODUCTION

Gastric outlet obstruction (GOO) is noted to be 10%-25% in patients with pancreatic



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and biliary malignancies[1]. The consequences of GOO, namely nausea, vomiting, and intolerance of oral feed, are troublesome and have a significant negative impact on the health of these patients. Recent advances in technical skills have pushed palliative endoscopic management ahead of the surgical approach in managing malignant GOO, as the outcomes are comparable and non-inferior to the advanced robotic gastro-jejunal bypass. Endoscopic management as a minimal access modality in combination with lower re-intervention, higher success, and reasonable patency rates appears promising and will stand out as a valuable alternative. The technical and clinical success rates are 96-100% and 82-91% for endoscopic placement of stents in malignant GOO[2]. The manuscript briefly overviews the current scenario in managing malignant GOO.

SURGICAL VS ENDOSCOPIC APPROACH

Compared to the endoscopic approach, conventional surgery is more invasive. Life expectancy of less than 2 months, poor general condition, and high risk for surgical intervention are factors acting as natural choices for endoscopic management [3,4]. Technical and clinical success rates were similar among endoscopic and robotic approaches. At the same time, the procedural time, the time to oral intake, and the post-procedure length of stay were significantly shorter in the endoscopy[5]. Although adverse events post-procedure are less in endoscopy, the need for secondary procedures due to stent block is higher. The cost analysis favours endoscopy when secondary procedures are not considered [6].

MALNUTRITION-IMPORTANCE AND EVALUATION

Baseline biochemical laboratory values such as albumin and haemoglobin serve as quick estimates of malnutrition assessment. Serum albumin can be a stand-alone parameter in nutritional evaluation. Low serum albumin levels were indicative of poor performance status. Levels lower than 2.8 mg/100 mL indicate elevated 90-day mortality in these patients. Although cancer cachexia is recognised as an incriminating factor, the low serum albumin levels may also be linked to the poor socioeconomic status of the patient[7].

Pre-designed screening tools such as Global Leadership Initiative on Malnutrition and Patient Generated Subjective Global Assessment are available for use in the ambulatory care of these patients. PGS GA short form is a simple, objective, and effective tool for patients to aid in nutritional assessment. These can serve as a standard guide with good detective value, enabling nutritional support for these patients[8].

LONG TERM OUTCOME

The assessment of quality of life (QOL) is a challenge in malignant GOO, given the morbidity of the cancer progression, difficulty in recruitment, ethical issues and reduced longevity. The prevailing misinterpretations regarding the various aspects of palliation, such as duration of survival, effective control of pain, ability to eat diet and their relative importance in the assessment of the QOL, require review for a better understanding of palliation. The patient's needs and objective measures, such as symptom-free survival, are essential to reframing the appropriate definition of QOL[9].

QOL Questionnaire gastric cancer module (QLQ-STO22) provides an example of a standard estimation of QOL as it includes a comprehensive questionnaire attempting to address and obtain a global overview of the patient symptomatology, which is vital to an objective assessment[10].

ROLE OF CHEMOTHERAPY

Chemotherapy has the benefit of prolongation of life expectancy in malignant GOO. In the setting of stent placement for palliation of obstructive symptoms, chemotherapy has the advantage of preventing tumour growth, which can potentially cause restenosis. Also, the time to progression of tumour advancement is slowed, so there is an advantage of improved and prolonged palliation. However, the downside of chemotherapy is stent migration in about 16%-25%[11], secondary to a decrease in tumour size leading to the loss of the hold of stent grip. Technical innovations to address stent migration include using uncovered stents, winged, partially covered stents, external snare fixation, over-the-scope clips, and endoscopic suture fixation. Initiation of chemotherapy after stenting is advocated as a safe and efficient measure for patients with reasonable functional status[12,13].

INTERVENTIONAL RADIOLOGY

Interventional radiology is an integral part of endoscopic therapy. Placement of a guide wire under fluoroscopy across the site of obstruction is an essential pre-requisite in procedural management. Fluoroscopy plays a role in the successful stent deployment by delineating the length of the obstruction to be overcome and providing guidance to navigate. Endoscopic sonographic guided gastro-enterostomy requires fluoroscopic guidance as an essential accompaniment for the safe and smooth conduct of the procedure[14].

ENDOSCOPIC GASTRO-ENTEROSTOMY

Endoscopic gastro-enterostomy has evolved as a successful means of minimal access procedure, which can be performed either antegrade or retrograde by deploying a lumen-apposing metallic stent. As an advanced endoscopic procedure, it takes advantage of the twin benefits of deploying a stent and achieving a bypass. The procedure can be accomplished by employing techniques such as antegrade endoscopic ultrasound direct method, antegrade endoscopic ultrasound traditional downstream method, antegrade endoscopic ultrasound direct over guidewire method, retrograde endoscopic ultrasound method and endoscopic balloon occluded bypass method. As the technical success rates are over 90%, with minimal complications, these endoscopic procedures are recommended for favourable outcomes [15,16].

FUTURE PROSPECTS

Endoscopic sonography guided gastro-enterostomy combines the benefits of self-expanding metallic stents and surgical gastro-jejunostomy, with the advantage of durable patency, effectiveness lasting longer, technical safety and minimally invasive. Although the procedure has a steep learning curve, it is likely to be the future modality of management [17].

The limitation of the manuscript is that it is not an exhaustive or systematic review, with no original data to expound on the various management options of malignant GOO.

CONCLUSION

Choosing the best route possible, establishing adequate intake, and eliminating specific complaints such as pain are the broad goals of palliating malignant GOO. Implementing the standard approach in conjunction with the patient's needs and the attenders' suitability would be the way to manage these patients. There are glaring lacunae in the available knowledge platforms concerning the malignant GOO, such as the need for standard tools for nutritional assessment, QOL assessment and chemotherapy issues, to name a few. It is essential to address the above concerns to achieve sustainable targets for patients with malignant GOO.

Vilas-Boas et al[18] present an insightful review of malignant GOO, highlighting the knowledge gaps and grey areas, paving the way for future research on the management options.

FOOTNOTES

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ORIGINAL ARTICLE

Retrospective Cohort Study

Outcomes of bile duct cannulation using a novel contrast-enhanced catheter: A single-center, retrospective cohort study

Toru Kaneko, Mitsuhiro Kida, Takahiro Kurosu, Gen Kitahara, Shiori Koyama, Nao Nomura, Kumiko Tahara, Chika Kusano

Specialty type: Gastroenterology and hepatology

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Abstract

BACKGROUND

Endoscopic retrograde cholangiopancreatography is a challenging procedure involving bile duct cannulation. Despite the development of several cannulation devices, none have effectively facilitated the procedure.

To evaluate the efficacy of a recently developed catheter for bile duct cannulation.

METHODS

We retrospectively examined 342 patients who underwent initial cholangiopancreatography. We compared the success rate of bile duct cannulation and the incidence of complications between the groups using existing and novel catheters.

RESULTS

The overall success rates of bile duct cannulation were 98.3% and 99.1% in the existing and novel catheter groups, respectively (P = 0.47). The bile duct cannulation rate using the standard technique was 73.0% and 82.1% in the existing and novel catheter groups, respectively (P = 0.042). Furthermore, when catheterization was performed by expert physicians, the bile duct cannulation rate was significantly higher in the novel catheter group (81.3%) than in the existing catheter group (65.2%) (P = 0.017). The incidence of difficult cannulation was also significantly lower in the novel catheter group (17.4%) than in the existing catheter group (33.0%) (P = 0.019).

CONCLUSION

The novel catheter improved the bile duct cannulation rate using the standard technique and reduced the frequency of difficult cannulation cases, valuable tool in endoscopic retrograde cholangiopancreatography procedures performed by experts.

Key Words: Endoscopic retrograde cholangiopancreatography; Bile duct; Cannulation; Catheter; Retrospective study

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Core Tip: The use of a novel contrast-enhanced catheter improved the bile duct cannulation rate when using the standard technique and reduced the frequency of cases with difficult cannulation. These advantages were particularly notable in procedures performed by experts. Further, its application by experts has shown promise in reducing the frequency of difficult cannulation, underscoring its utility in clinical practice.

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INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is useful for diagnosing and treating conditions affecting the biliopancreatic region[1-3]. ERCP is commonly used to manage diseases such as choledocholithiasis, obstructive jaundice, pancreaticobiliary malignancies, chronic pancreatitis, and biliary strictures. ERCP enables visualization of the biliary and pancreatic ducts and offers avenues for therapeutic interventions such as stone removal, stent placement, and tissue sampling for pathological examination. Notably, ERCP is a complex procedure involving several techniques, with selective bile duct cannulation being the initial and often challenging step. Selective bile duct cannulation is the first fundamental procedure to access the bile duct during ERCP. However, even experts can find it difficult to perform this procedure in some cases, with reports indicating a failure rate of approximately 5%-20% for selective bile duct cannulation in patients with a first papilla[4-7]. Difficulties in selective bile duct cannulation have been reported due to variations in patient anatomy, such as a parapapillary diverticulum or a specific papilla morphology[8-10] as well as differences in endoscopist skills[8-11]. Watanabe *et al*[10] focused on oral protrusion and difficulty in bile duct cannulation and reported that large oral protrusion papillae with large oral ridges are the most difficult to intubate and are the most likely causes of bile duct cannulation difficulties. Moreover, others have reported that the success rate of ERCP and the frequency of incidents are correlated with differences in endoscopists' experience and skills and the number of experienced endoscopists at a facility[11].

Various methods and devices have been developed to improve success rates of bile duct cannulation. The conventional contrast-guided cannulation has been widely used; however, in 1987, Siegel *et al*[12] reported the wire-guided cannulation (WGC) method using a guidewire (GW), which has now gained broad adoption in routine practice. In some cases, bile duct cannulation is difficult using only these standard methods. Therefore, various methods have been devised for such cases, including pre-cutting[13], the double- GW technique with a GW placed in the pancreatic duct[14], two devices in one-channel method[15], endoscopic ultrasound (EUS)-guided rendezvous technique[16], and various other bile duct cannulation methods.

Approximately 10% of patients undergoing ERCP experience incidental complications[17]. Post-ERCP pancreatitis (PEP) is the most fatal incidental complication of ERCP[18]. Repeated cannulation attempts increase the risk for PEP[19]. These findings underscore the importance of facilitating bile duct cannulation to improve its success rate and reduce accidental injuries such as PEP. Recently, a novel type of catheter for cholangiography has been introduced to the market. The catheter is soft and has a chamfered tip, which allows cannulation of the bile duct without stress on the bile duct and may facilitate the procedure. A previous study comparing sphincterotomes and contrast-enhanced catheters reported that WGC with sphincterotomes had a higher rate of selective bile duct cannulation and smaller incidence of PEP[20], whereas others reported that the rate of selective bile duct cannulation and the incidence of PEP was the same[21]. However, to the best of our knowledge, no study using the new catheter has been conducted. Therefore, this study aimed to retrospectively evaluate the effects of the new cholangiographic catheter on cannulation, providing insights into its potential to improve procedural outcomes.

MATERIALS AND METHODS

Study design

This single-center, retrospective cohort study was conducted at Kitasato University Medical Center in Japan. The study was performed in accordance with the Declaration of Helsinki and approved by our hospital's Institutional Review Board, approval No. 2023011. All participants provided written informed consent before the procedure.

Target patients

We retrospectively reviewed the medical records of patients who underwent ERCP at Kitasato University Medical Center from April 2020 to September 2023. During the specified period, 914 patients underwent ERCP, and those who met the inclusion criteria and none of the exclusion criteria were enrolled. The inclusion criteria were as follows: (1) History of ERCP for bile duct cannulation; and (2) Initial untreated papilla (naive papilla). The exclusion criteria were as follows: (1) History of ERCP for pancreatic diseases; (2) History of upper gastrointestinal surgery except the Billroth1 procedure; and (3) Duodenal stenosis that prevented endoscopic insertion to the duodenal papilla. Finally, a total of 342 patients fulfilled these criteria (Figure 1).

Study protocol (Figure 1)

From April 2020 to July 2022, an existing catheter (MTW ERCP catheter; MTW Endoscopy, Wesel, Germany) was used, and from August 2022 to September 2023, a novel catheter (FineJet Cannula; Gadelius Medical, Tokyo, Japan Gadelius Medical Co. Ltd., Tokyo, Japan) was used for ERCP. Of the 342 patients with untreated papillae, 230 were treated with the existing catheter, and 112 were treated using the novel catheter.

Novel catheter

The novel catheter is a disposable contrast-enhanced catheter with a 4.4 French tapered and chamfered tip (Figure 2A). The shaft diameter is 7 French and total length is 220 cm, with a central lumen accommodating up to 0.035 inches of GW and contrast medium (Figure 2B). This configuration allowed simultaneous GW operation while contrast medium flows through the lumen. The catheter has a soft overall structure owing to its large central lumen.

Definition

Bile duct cannulation using only a contrast-enhanced catheter or WGC was defined as the standard technique, whereas cases wherein the catheter was changed to a sphincterotome (Clever Cut 3V; Olympus Medical Systems, Tokyo, Japan), pancreatic duct GW technique, or pre-cut two devices in one channel technique were defined as rescue techniques. Successful bile duct cannulation was defined as successful insertion of the catheter into the bile duct and successful cholangiography. Difficulty in bile duct cannulation was defined as five or more (> 5) attempts at bile duct cannulation. The procedure time was defined as the time from endoscope insertion to removal, and the bile duct cannulation time was defined as the time from the frontal view of the duodenal papillae to successful bile duct cannulation. Experts were defined as those with experience of performing > 500 ERCP procedures. When a trainee performs ERCP, the expert performs it together with the trainee as a caregiver in a supervisory position. large oral protrusion was defined as the length of the oral protuberance that was at least twice the lateral diameter of the duodenal papilla[15]. Adverse events (AE) severity was classified according to the lexicon of the American Society of Gastrointestinal Endoscopy[22].

The primary endpoint was the success rate of bile duct cannulation using only contrast-enhanced catheters. The secondary endpoints included the overall rate of bile duct cannulation, frequency of difficult cannulation cases, and incidence of AE.

ERCP procedure

Pethidine hydrochloride and midazolam were used for sedation. A duodenoscope (TJF290V, TJF260V, or JF260V; Olympus Medical Systems, Tokyo, Japan) was inserted into the duodenal papilla. The opening of the duodenal papillae was viewed in the frontal plane, and the bile duct was intubated with a GW (Visiglide2; Olympus Medical Systems, Filder25; Asahi Intech, Aichi, Japan) inserted into a contrast-enhanced catheter. Bile duct cannulation was initially performed using contrast-enhanced or conventional WGC. When bile duct cannulation was difficult, a rescue method was used, and the surgeon decided which method to use. Pre-cutting was performed via freehand fistulotomy using a Needle Knife (Needle Cut 3V; Olympus Medical Systems). After bile duct cannulation, endoscopic sphincterotomy, endoscopic lithectomy, or endoscopic biliary drainage was performed according to the case requirements. When a trainee performed ERCP and had difficulty intubating the bile duct, an expert replaced them after at least 10 minutes or ≥ 5-10 attempts.

Statistical analysis

According to a previous report [23], the success rate of bile duct cannulation using the conventional method is 62.8%. Assuming that the success rate improves to 80% when using a novel catheter, with an alpha error of 5% and a power of 80%, the required sample size for each group was calculated to be 105. Considering ineligible patients, we planned to include 112 patients in the novel catheter group. However, the existing catheter group had a significantly larger number of cases than the novel catheter group during the study period, with 230 cases observed, which exceeded the initially

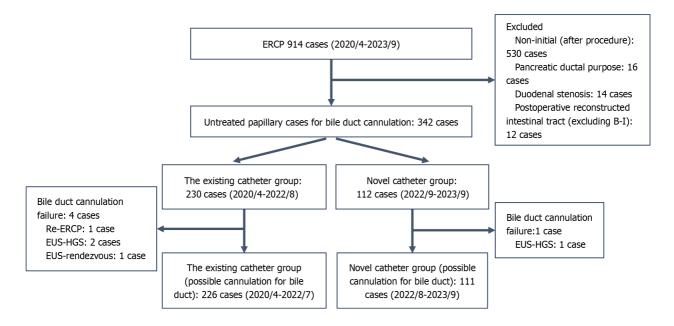


Figure 1 Study flowchart. ERCP: Endoscopic retrograde cholangiopancreatography; EUS: Endoscopic ultrasound: EUS-HGS: Endoscopic ultrasound-guided hepaticogastrostomy; EUS-rendezvous: Endoscopic ultrasound-quided rendezvous technique.

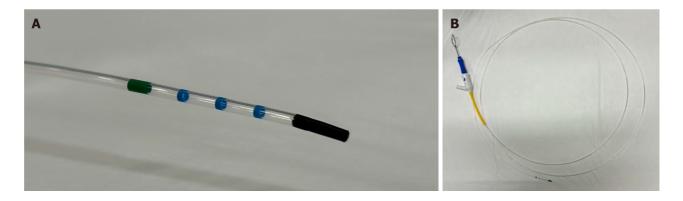


Figure 2 Novel catheter. A: The tip of the catheter is tapered and chamfered; B: Overall view.

calculated sample size of 105 cases. Therefore, the number of cases observed during the observation period was used to define the sample size.

Statistical analysis was performed using SPSS version 17.0 (IBM Corp., Armonk, NY, United States) and R statistical package version 3.2.4 (R Foundation for Statistical Computing, Vienna, Austria). Continuous variables are expressed as medians and interquartile ranges, whereas categorical variables are presented as percentages and absolute numbers. Continuous variables were compared using the Mann-Whitney U-test, whereas categorical variables were compared using Fisher exact tests. All P values were two-sided, and statistical significance was set at P < 0.05. All authors have access to and reviewed the study data and approved the final manuscript.

RESULTS

Baseline characteristics

A total of 342 patients were identified using database analysis. Among these, 230 patients underwent ERCP with existing catheters, and 112 with novel catheters. Table 1 describes the patients' baseline characteristics. No significant differences were noted in age, sex, or primary disease between the existing and novel catheter groups. Similarly, no significant differences were observed in anatomical factors affecting bile duct cannulation[13-15], such as parapapillary diverticulum and long oral ridge, between the two groups. Further, no significant difference was noted between expert and non-expert physicians who performed the procedure in the two groups.

Overall results

Table 2 presents the overall treatment results. The overall rates of bile duct cannulation were 98.2% and 99.1% in the

Table 1 Baseline characteristics of the existing and novel catheter groups, n (%)					
Character	Existing catheter group (n = 230)	Novel catheter group (n = 112)	P value		
Age median (range)	77 (29-97)	80.5 (44-104)	0.84		
Sex (male/female)	144/96	56/56	0.874		
Primary disease					
Benign disease	147 (63.9)	73 (65.1)	-		
Bile duct stones	134 (58.2)	66 (58.9)	-		
Benign bile duct stricture	6 (2.6)	2 (1.8)	-		
Other (benign)	7 (3.0)	5 (4.5)	-		
Malignant disease	83 (36.1)	39 (34.8)	-		
Pancreatic cancer	33 (14.3)	16 (14.2)	-		
Cholangiocarcinoma	46 (20.0)	22 (19.6)	-		
Other (malignant)	4 (1.7)	1 (0.9)	-		
Benign/malignant disease	147/83	73/39	0.90		
Parapapillary diverticular papilla	60 (26.1)	27 (24.1)	0.79		
Oral protrusion-large	60 (26.1)	28 (25.0)	0.90		
Expert/non-expert	115/115	64/48	0.25		

existing and novel catheter groups, respectively, with no significant differences. Bile duct cannulation was not possible in five patients (1.5%): One patient underwent repeat ERCP to allow bile duct cannulation, three underwent EUS-guided hepaticogastrostomy, and one underwent bile duct cannulation using the EUS-guided rendezvous technique. The frequencies of difficult cannulation were 41.6% with existing catheters and 32.4% with the novel catheter, with no significant difference. In contrast, the rates of bile duct cannulation with the standard technique were 74.3% for existing catheters and 82.9% for the novel catheter, with a significant difference (P = 0.042). The incidences of AE were 5.2% in the existing catheter group and 4.5% in the novel catheter group, with no significant difference. The incidences of PEP were 4.3% in the existing catheter group and 2.7% in the novel catheter group, with no significant difference observed.

Non-expert treatment performance

Table 3 presents the treatment performance results achieved by non-experts. The overall rates of bile duct cannulation were 99.1% in the existing catheter group and 100% in the novel catheter group, with no significant difference. The frequencies of difficult cannulation were 49.1% and 52.1% in the existing and novel catheter groups, respectively, with no significant differences. The rates of bile duct cannulation using the standard technique were 79.1% for the existing catheter group and 83.3% for the novel catheter group, with no significant differences. The incidences of AE were 3.5% in the existing catheter group and 6.3% in the novel catheter group, with no significant difference, and those of PEP were 2.6% in the existing catheter group and 2.1% in the novel, with no significant difference.

Expert treatment performance

Table 4 presents the treatment outcomes achieved by experts. The overall rates of bile duct cannulation were 97.3% and 98.4% in the existing and novel catheter groups, respectively, with no significant differences. The frequencies of difficult cannulation were 33.0% and 17.4% in the existing and novel catheter groups, respectively, with significantly less difficult cannulation in the novel catheter group (P = 0.019). The rates of bile duct cannulation with the standard technique were 65.2% for the existing catheters and 81.3% for the novel catheter, with a significant difference (P = 0.017). The incidences of AE were 7.0% in the existing catheter group and 3.1% in the novel catheter group, with no significant difference. The incidences of PEP were 6.1% in the existing catheter group and 3.1% in the novel catheter group, with no significant difference.

DISCUSSION

In this study, we explored the usefulness of bile duct cannulation using a novel catheter in ERCP. Selective bile duct cannulation is an important step in ERCP, as it serves as a gateway to subsequent interventions. Moreover, patients with difficult bile duct cannulation are at high risk for PEP[8], underscoring the importance of facilitating this aspect of the procedure.

Our investigation revealed that the use of the novel catheter improved the rate of bile duct cannulation using the standard technique. This improvement could potentially be attributed to the catheter's chamfered tip and softness,

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Character	Existing catheter group (n = 230)	Novel catheter group (n = 112)	P value
Cannulation success rate	98.3% (226/230)	99.1% (111/112)	0.47
Number of attempts of cannulation, median (range)	3 (1-20)	3 (1-10)	0.58
Difficult cannulation (> 5 times)	94 (40.9)	36 (32.1)	0.074
Cannulation success rate with the standard technique	73.0% (168/230)	82.1% (92/112)	0.042
Rescue technique			
Switch to sphincterotomes	8 (3.5)	0	0.039
Pancreatic duct GW method	14 (6.1)	2 (1.8)	0.059
Precut	35 (15.2)	17 (15.3)	0.56
Two devices in one channel method	1 (0.4)	0	0.67
Cannulation failure	4 (1.7)	1 (0.9)	0.47
Re-ERCP	1 (0.4)	0	0.67
EUS-HGS	2 (0.9)	1 (0.9)	0.70
EUS-rendezvous	1 (0.4)	0	0.67
Adverse event			
Total	12 (5.2)	5 (4.5)	0.70
Bleeding	2 (0.9)	2 (1.8)	0.60
PEP	10 (4.3)	3 (2.7)	0.59
Mild	9 (3.9)	2 (1.8)	0.51
Moderate disease	1 (0.4)	1 (0.9)	0.55
Severe disease	0	0	-

GW: Guide wire; ERCP: Endoscopic retrograde cholangiopancreatography; EUS: Endoscopic ultrasound; EUS-HGS: Endoscopic ultrasound-guided hepaticogastrostomy; EUS-rendezvous: Endoscopic ultrasound-guided rendezvous technique; PEP: Post-endoscopic retrograde cholangiopancreatography pancreatitis.

facilitating its alignment with the bile duct axis. This finding was supported by the fact that no cases of sphincterotome conversion were noted in the novel catheter group. The sphincterotome catheter can be adjusted by stretching the knife in the direction of the catheter, making it easier to look up and align with the bile duct axis, with a study reporting that the rate of bile duct cannulation was higher with the sphincterotome than with a conventional contrast catheter[20]. However, the characteristics of the new catheter suggest that it can be aligned with the bile duct axis without using a

The rate of bile duct cannulation was higher with the novel catheter using the standard technique than with existing catheters; however, the overall rate showed a trend toward a lower incidence of difficult cannulations, but the difference was not statistically significant. Difficult cannulation is considered a risk factor for PEP[19]; therefore, reducing the frequency is important to reduce the risk of PEP and perform safe ERCP. To examine the results of this study in detail, we determined whether the participating physicians were experts or non-experts. No significant differences were observed between the novel and the existing catheter groups. Meanwhile, the use of novel catheters in the expert group decreased the frequency of difficult cannulation and increased the bile duct cannulation rate using the standard technique compared with the use of existing catheters. However, the incidence of AE was similar between the two groups. These results suggest that using the novel catheter facilitated bile duct cannulation in the expert group. This may be because the experts could understand the characteristics of the novel catheter and orient it toward the bile duct axis. Consequently, treatment outcomes may be more favorable.

Furthermore, rescue techniques such as the double- GW technique with a GW placed in the pancreatic duct and pre-cut have been reported to increase the risk of PEP[19,24,25]. Therefore, our study's results hold significance, as a higher rate of bile duct cannulation using only the standard technique may reduce the risk of PEP. The incidences of AE were 5.2% in the existing catheter group and 4.5% in the novel; however, this difference was not significant. The incidences of pancreatitis after ERCP decreased to 4.3% and 2.7% in the existing and novel catheter groups, respectively. However, there was a trend toward fewer cases reported in both groups, although the difference was not significant [17]. No serious complications were observed in either of the groups. Reportedly, the incidence of AE increased when ERCP was performed by non-experts or at institutions with limited experience. However, in this study, even when non-experts performed ERCP,

Table 3 Outcomes for each group when a non-expert is the practitioner, n (%)

Character	Existing catheter group (<i>n</i> = 115)	Novel catheter group (n = 48)	P value
Cannulation success rate	99.1% (114/115)	100% (48/48)	0.71
Number of attempts of cannulation median (range)	4.5 (1-20)	5 (1-10)	0.67
Difficult cannulation (> 5 times)	56 (48.7)	25 (52.1)	0.73
Cannulation success rate with the standard technique	79.1% (91/115)	83.3% (40/48)	0.66
Rescue technique			
Switch to sphincterotomes	2 (1.7)	0	0.47
Pancreatic duct GW method	5 (4.3)	1 (2.1)	0.67
Precut	13 (11.3)	7 (14.6)	0.60
Two devices in one channel method	1 (0.9)	0	0.69
Cannulation failure	1 (0.9)	0	0.69
Re-ERCP	0	0	-
EUS-HGS	1 (0.9)	0	0.69
EUS-rendezvous	0	0	-
Adverse event			
Total	4 (3.5)	3 (6.3)	0.50
Bleeding	1 (0.9)	2 (4.2)	0.21
PEP	3 (2.6)	1 (2.1)	0.66
Mild disease	3 (2.6)	1 (2.1)	0.66
Moderate disease	0	0	-
Severe disease	0	0	-

GW: Guide wire; ERCP: Endoscopic retrograde cholangiopancreatography; EUS: Endoscopic ultrasound; EUS-HGS: Endoscopic ultrasound-guided hepaticogastrostomy; EUS-rendezvous: Endoscopic ultrasound-guided rendezvous technique; PEP: Post-endoscopic retrograde cholangiopancreatography pancreatitis.

the incidences of incidental injury were 3.5% in the existing catheter group and 6.3% in the novel catheter group, with a low incidence in both groups. The incidences of pancreatitis after ERCP were 2.6% in the existing catheter group and 2.1% in the novel catheter group, even when non-experts performed catheterization. In this study, non-experts were assisted by an expert in the supervisory position when performing ERCP. As a result, the procedure could be performed safely, and the incidence of accidental injury was low in both groups.

In recent years, endoscopic ultrasonography-guided biliary drainage has gained popularity as an alternative in patients who have difficulty with ERCP[26-28]. The treatment results were excellent and comparable with those of ERCP[29]. However, there are cases in which EUS-guided biliary drainage cannot be performed, such as in patients with very narrow bile ducts or large amounts of ascites. Therefore, improving the success rate of ERCP is important. Our study highlights the efficacy of the novel catheter in improving the rate of bile duct cannulation using the conventional method, thus filling a notable gap in existing literature.

This study has some limitations. First, this was a single-center retrospective study, with a small sample size. Second, because there were multiple surgeons, the choice of the ERCP technique was not constant and depended on the choice of the endoscopist, which may have led to bias. In the future, it would be desirable to study a larger number of cases considering all these factors. In addition to a larger sample size, performing a randomized controlled trial to compare the efficacy and safety of new and conventional catheters would be helpful.

CONCLUSION

This novel catheter improved the success rate of bile duct cannulation using the conventional method. Further, its application by experts has shown promise in reducing the frequency of difficult cannulation, underscoring its utility in clinical practice.

Table 4 Outcome a	foodbaroup u	than an avnart is t	the practitioner, n (%)
Table 4 Outcome o	r each droub v	vnen an expert is t	ne bractitioner. n (%)

Character	Existing catheter group (n = 115)	Novel catheter group (n = 64)	P value
Cannulation success rate	97.3% (112/115)	98.4% (63/64)	0.55
Number of attempts of cannulation median (range)	2 (1-18)	2 (1-10)	0.67
Difficult cannulation (> 5 times)	37 (32.1)	11 (17.2)	0.021
Cannulation success rate with the standard technique	65.2% (75/115)	81.3% (52/64)	0.017
Rescue technique			
Switch to sphincterotomes	6 (5.2)	0	0.067
Pancreatic duct GW method	9 (7.8)	1.6% (1/64)	0.073
Precut	22 (19.1)	15.6% (10/64)	0.36
Two devices in one channel method	0	0	-
Cannulation failure	3 (2.7)	1 (1.6)	0.55
Re-ERCP	1 (0.9)	0	0.64
EUS-HGS	1(0.9)	1 (1.6)	0.59
EUS-rendezvous	1 (0.9)	0	0.64
Adverse event			
Total	8 (7.0)	2 (3.1)	0.24
Bleeding	1 (0.9)	0	0.64
PEP	7 (6.1)	2 (3.1)	0.31
Mild disease	6 (5.2)	1 (1.6)	0.39
Moderate disease	1 (0.9)	1 (1.6)	0.64
Severe disease	0	0	-

 $GW: Guide\ wire;\ ERCP:\ Endoscopic\ retrograde\ cholangiopan creatography;\ EUS:\ Endoscopic\ ultrasound;\ EUS-HGS:\ Endoscopic\ ultrasound-guided$ hepaticogastrostomy; EUS-rendezvous: Endoscopic ultrasound-guided rendezvous technique; PEP: Post-endoscopic retrograde cholangiopancreatography pancreatitis.

FOOTNOTES

Author contributions: Kaneko T conceptualized the study, carried out data collation, conducted formal analysis and surveys, was responsible for methodology, project management, validation and visualization, and participated in writing the original manuscript; Kurosu T, Kitahara G, Koyama S, Nomura N, and Tahara K were responsible for the resources; Kida M and Kusano C supervised the study; Kaneko T, Kida M, Kurosu T, Kitahara G, Koyama S, and Kusano C were involved in writing review and editing; and all authors have read and approved the final manuscript.

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Informed consent statement: All participants provided written informed consent before the procedure.

Conflict-of-interest statement: All the authors report no relevant conflicts of interest for this article.

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STROBE statement: The authors have read the STROBE Statement-checklist of items, and the manuscript was prepared and revised according to the STROBE Statement-checklist of items.

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ORIGINAL ARTICLE

Retrospective Study

Endoscopic retrograde cholangiopancreatography for patients aged ninety and older with choledocholithiasis: A single-center experience in south China

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Abstract

BACKGROUND

Endoscopic retrograde cholangiopancreatography (ERCP) serves an essential role in treating biliary diseases, especially in choledocholithiasis. However, due to the limited human lifespan, there remains a paucity of clinical investigations on ERCP treatment in patients over 90 years old.

AIM

To explore the effectiveness and safety of ERCP in super-older patients aged \geq 90 years with choledochal stones.

METHODS

This study retrospectively analyzed data from patients (aged \geq 65 years) with choledocholithiasis who received ERCP treatment in our hospital from 2011 to 2023. Among them, patients \geq 90 years old were in the super-older group, and patients aged 65-89 years were in the older group. Baseline data, including gender, number of stones, stone size, gallbladder stones, periampullary diverticulum, and common bile duct intubation of patients in the two groups, were matched by adopting the 1:1 propensity score matching method.

RESULTS

After matching, 44 patients were included in both the super-older group and the older group. The incidence of stroke in the super-older group was markedly higher than that in the older group [34.1% (15/44) vs 6.8% (3/44), P = 0.008]. The success rate of the ERCP procedure in the super-older group was 90.9% (40/44), compared to that in the older group [93.2% (41/44), P = 1.000]. Although endoscopic papillary balloon dilation was more frequently used in the super-older group than in the older group [61.4% (27/44) vs 18.2% (8/44), P < 0.001], there

was no significant difference in terms of stone removal rate, the incidence of complications, mortality, recurrence, and length of hospitalization between the two groups (P > 0.05).

CONCLUSION

ERCP is safe and effective in super-older patients ≥ 90 years old with choledocholithiasis.

Key Words: Endoscopic retrograde cholangiopancreatography; Choledocholithiasis; Super-older; Safety; Complications

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Core Tip: For the number of super-older patients with choledocholithiasis is small, only a few studies have investigated the therapeutic effects of endoscopic retrograde cholangiopancreatography (ERCP) in such patients, which is insufficient in this rapidly aging world. The aim of this study was to compare the safety and efficacy of ERCP in patients aged 90 and older with patients aged 65-89 years by using a propensity score matching method to reduce bias. After matching, 44 patients were included in each group and our results showed no significant difference in the rates of successful ERCP procedures or complications between the two groups.

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INTRODUCTION

According to the latest statistics report from the World Health Organization[1], with the general increase in human life expectancy, the number of older adults is growing year by year, especially in China[2]. Based on the redefinition of older adults by the Joint Committee of the Gerontological Society of Japan and the Japanese Geriatrics Society, individuals aged 65 to 74 are considered as pre-old, those aged 75 and above are regarded as old, and those aged 90 and above are classified as super-old[3]. In contrast, in China, individuals aged ≥ 65 years are generally considered older adults[4]. Given that choledithiasis is a highly prevalent disease in China and that choledocholithiasis accounts for 10%-15% of cholelithiasis cases[5], the number of older patients with choledocholithiasis is substantial, with super-older individuals becoming increasingly common among them. Since the complication and mortality rate of choledochotomy in older patients with choledocholithiasis are higher compared to younger patients [6,7], endoscopic retrograde cholangiopancreatography (ERCP) is of great significance as a minimally invasive therapeutic modality with low complication and mortality rate for older patients with choledochotomy stones[8-10]. However, post-operative complications of ERCP, such as post-ERCP pancreatitis, hemorrhage, biliary tract infection, perforation, and intraoperative mesh basket entrapment, can still pose a serious impact on older patients, especially the super-older patients[11]. Although several studies have indicated that ERCP could be safely applied even in patients ≥ 90 years old[12,13] and may contribute to longer survival in these super-older patients [14,15], a recent multivariate analysis still identified age ≥ 90 years as a significant risk factor for adverse events during therapeutic ERCP[16]. Thus, it is highly necessary to make further evaluations of the effectiveness and safeness of ERCP for super-older patients with choledocholithiasis. However, research on this topic remains limited, particularly in south China.

MATERIALS AND METHODS

Study participants and design

This study conducted a retrospective analysis of the medical records of older patients diagnosed with choledochal stones, who were treated with ERCP in the Department of Hepatobiliary Surgery in our hospital during the period from January 2011 to December 2023. The inclusion criteria were as follows: (1) Compliance with the diagnostic criteria for choledochal stones in the Chinese ERCP guideline (2018 edition)[17]; (2) Patients aged ≥ 65 years; (3) Receipt of ERCP treatment; (4) Presence of a normal gastrointestinal tract or undergoing Billroth I reconstruction; and (5) Availability of complete relevant clinical data. The exclusion criteria were: (1) Patients aged < 65 years; (2) Those not receiving ERCP treatment; (3) A history of Billroth II or Roux-en-Y gastrointestinal tract reconstruction; and (4) Incomplete clinical data. After filtering on the basis of the inclusion and exclusion criteria, a total of 428 patients aged ≥ 65 years qualified for the inclusion criteria. This cohort included 45 patients aged ≥ 90 years (super-older group) and 383 patients aged 65-89 years (older group). The patients were matched for baseline data on gender, number of stones, size of stones, gallbladder stones, peripapillary diverticulum, and successful choledochal intubation, and the two groups were compared for surgical success, stone retrieval rate, complication rate, and hospitalization duration. Ultimately, a total of 44 cases were incorporated into the super-older group, while an equal number of 44 cases were included in the older group. This study was approved by the ethics committee of Guangzhou Red Cross Hospital of Jinan University (approval No. 2024-249-01).

ERCP procedure and perioperative management

All patients were adequately informed about the procedure and provided their written informed consent prior to the operation. An electronic duodenoscope (TJF-260V, Olympus, Tokyo, Japan) and the main unit system (Evis-Exera II CLV-180, Olympus) were used in all procedures. ERCP was performed by two experienced endoscopists, each of whom had operated on more than 1000 ERCP procedures. All patients were classified in accordance with the American Society of Anesthesiologists (ASA) physical status assessment before ERCP. Routine examinations included blood tests, two items of infection (procalcitonin and interleukin-6), liver function, renal function, coagulation function, markers of heart failure, electrocardiogram, chest radiograph, cardiac ultrasound, and abdominal computed tomography (CT) or magnetic resonance/magnetic resonance cholangiopancreatography. Patients were asked to fast for 6 to 12 hours before ERCP.

For patients with fair preoperative basal status who were able to tolerate surgery in the prone position, 10% lidocaine was administered for 15 minutes of surface anesthesia of the gastrointestinal tract. They were routinely injected with intramuscular pethidine hydrochloride injection (75 mg) for analgesia, intravenous diazepam injection (5-10 mg) for sedation, and resorcinol injection (40-80 mg) to inhibit duodenal peristalsis before the operation [18]. These medications were used to perform cholangiography. For patients with severe underlying diseases who could not tolerate a prone position or endoscopy after surface anesthesia and sedation or who strongly requested general anesthesia, general anesthesia was performed *via* endotracheal intubation. This was performed under the supervision of anesthesiologists after a preoperative evaluation by the anesthesiology department. During the procedure, cardiac monitoring and oxygenation were provided, and appropriate intravenous access was established.

Selective bile duct intubation was routinely performed using a disposable papillary sphincter arched dissector (Nanwei Medical Technology, Nanjing, China). After successful intubation, cholangiography was performed using a 30% pantethine-glucosamine (diluted in saline) contrast agent to determine the number, size, and location of the common bile duct stones. Depending on the patient's preoperative use of antiplatelet or anticoagulant medications, the characteristics of the stones seen on intraoperative imaging, and the condition of the large duodenal papilla (size of the papilla and proximity to or involvement in a diverticulum), the decision was made to perform endoscopic sphincterotomy (EST), endoscopic papillary balloon dilation (EPBD), or a combination of both. In general, for most patients, EST was the preferred choice. However, EPBD was used for patients on antiplatelet or anticoagulant therapy or those with an intradiverticular papilla or one very close to a diverticulum. For common bile duct stones > 1.0 cm, a combination of EST and EPBD was considered. For patients who had difficulty being intubated with an arched dissector, papillary pre-dissection using a needle dissector was attempted, followed by bile duct intubation. For choledochal stones < 1.0 cm in diameter, stones were extracted after EST using a stone extraction balloon, mesh basket, or both, usually in a single session. For stones > 1.0 cm in diameter, EST was combined with EPBD, and a lithotripsy mesh basket was used to break up the stones before extraction. If residual stones were observed on cholangiography, they were removed using a combination of techniques. In cases with a large number of stones that were difficult to remove at one time, poor patient tolerance, patients unable to lie prone for a long time, patients receiving antiplatelet or anticoagulant drugs before ERCP, or insufficient bridging time to perform an emergency ERCP, a nasobiliary drainage tube or a biliary stent was placed to temporarily alleviate the emergency. A subsequent procedure was scheduled to remove the stones. If the patient's vital signs became unstable during ERCP, the procedure was terminated immediately, and appropriate resuscitation was initiated. Patients exhibiting unstable vital signs following the procedure were relocated to the intensive care unit (ICU) for further management and treatment.

Postoperatively, routine interventions included cardiac monitoring, oxygen, fasting, fluid replacement, anti-infection, and omeprazole for acid control. Abdominal signs, nasal bile duct drainage flow and characteristics, and changes in vital signs were closely observed. Laboratory examinations such as blood routine, blood amylase, liver function, and infection markers were dynamically rechecked at 3-6 hours, 24 hours, and 48 hours after the procedure. If complications such as postoperative pancreatitis, bleeding, perforation, or infection occurred, timely and appropriate treatment was carried out according to the Chinese ERCP guidelines (2018 edition)[17].

Research definitions

Acute cholangitis refers to the diagnosis and grading of acute cholangitis in accordance with the 2018 edition of the Tokyo Guidelines[19]. Post-ERCP complications and management include the following items.

Post-ERCP pancreatitis: One of the most serious post-ERCP complications is pancreatitis. The widely accepted consensus definition of post-ERCP pancreatitis includes the following criteria: (1) Typical pancreatitis pain in the epigastrium (acute onset of persistent, epigastric pain); (2) Blood amylase level three times or more above the upper limit of normal value; and (3) Abdominal enhanced CT or magnetic resonance imaging showing typical pancreatitis. Post-ERCP pancreatitis is diagnosed when any two of the above three conditions are met[20]. After the occurrence of acute pancreatitis, standardized treatment is carried out according to the treatment guidelines, and the treatment is as follows: (1) Immediate fasting and water restriction to reduce the burden on the pancreas; (2) Active medication, such as inhibiting pancreatic enzyme secretion by using omeprazole sodium to reduce the progression of pancreatitis and antibiotics to prevent infection when necessary; (3) Timely imaging, including pancreas CT or magnetic resonance imaging, and other imaging tests to assess the severity and extent of pancreatitis; (4) Active supportive therapy to replenish water and electrolytes for maintaining stable blood circulation; and (5) Close monitoring of changes in vital signs.

Hyperamylasemia: Defined as a serum amylase level at least three times higher than the upper limit of the normal range without obvious clinical symptoms. Patients may be observed without specific treatment and dynamic rechecks of serum amylase levels to clarify disease progression.

Bleeding: Bleeding is identified by the presence of blood in vomit or black stools, a decrease in hemoglobin concentration of at least 2 g/L, or the need for a blood transfusion. Management depends on the severity of bleeding and specific circumstances: (1) Conservative treatment, such as appropriate rehydration and hemostatic drugs; (2) Re-endoscopic hemostatic treatment; (3) Interventional treatment; and (4) Surgical operation if endoscopic interventional treatments are ineffective in controlling the bleeding.

Perforation: Perforation is indicated by imaging evidence of retroperitoneal or gastrointestinal perforation. Risk factors for perforation during operation should be clarified intraoperatively, and prompt treatment - conservative, endoscopic, or surgical - should be initiated based on the specific situation.

Infection: Defined as elevated temperature (> 38 °C), leukocytosis, with or without abdominal pain. The management of post-ERCP infection involves many aspects, and the key treatments are as follows: (1) Pre-operative prophylactic anti-infective treatment; (2) Adequate post-operative biliary drainage, monitoring the biliary drainage closely, and intensifying the anti-infective treatment if necessary; (3) If the infection is uncontrollable, the infected lesion needs to be clarified in time, including re-surgery if required; and (4) Close monitoring and nursing care.

Stone removal, incomplete stone removal, and stone size: Stone removal was defined as no stones on final cholangiography. Incomplete stone removal was defined as successful biliary intubation but an inability to remove the stones completely. The size of the stones was determined by measuring the maximum diameter of the largest stone present, while stones that resembled biliary sediments were assigned a value of 0 if their diameter could not be accurately measured.

Successful ERCP procedure: Successful ERCP procedure was defined as stone extraction, successful biliary intubation, and successful retention of a nasociliary tube or placement of a biliary stent in the intended location.

Emergency ERCP: Emergency ERCP is defined as emergency biliary drainage in the diagnosis and classification of acute cholangitis in accordance with the 2018 edition of the Tokyo guidelines: Biliary drainage for relief of obstruction within 24 hours of admission to the hospital[19].

Recurrence: Recurrence was defined as readmission for choledocholithiasis during the study period after the prior removal of choledochal stones.

Statistical analysis

Rigorous statistical analysis was conducted to identify differences between the patient groups. The independent samples t-test and Mann-Whitney U-test were used to assess differences in continuous variables between the two groups. For count data, the χ^2 -test or Fisher's exact probability method was used to compare the differences between the two groups. In order to reduce the potential confounding bias between groups, this study used the propensity score matching (PSM) method to match participants[21]. First, propensity scores were constructed through multivariate logistic regression models. Following score calculation, a 1:1 propensity-matched scoring method was used to match patients in both groups based on baseline variables, including the number of stones, stone size, gallbladder stones, peripapillary diverticulum, and successful choledochal intubation. A caliper width of 0.02 was set to ensure the quality of the match and to reduce sample loss during the matching process. After matching, post-matched data were considered as paired samples. Paired-sample t-tests and Wilcoxon signed-rank tests were used to assess the differences in post-PSM measures between the two groups. McNemar's test was used to compare the difference between the two groups using count data after PSM matching. The matched dataset was evaluated for covariate balance by examining the standardized mean difference. An absolute value of the difference in means less than 0.2 signifies successful matching[22,23]. All statistical tests were conducted as two-sided, and a P value of less than 0.05 was regarded as indicative of a statistically significant difference. Data analysis was conducted utilizing SPSS 27.0 statistical software (IBM, Armonk, NY, United States).

RESULTS

Baseline information on demographic and clinical characteristics

After matching, there was no statistically significant difference between the two groups in terms of overall underlying diseases and the proportion of patients with ≥ 2 underlying conditions. However, significantly more patients in the super-older group had a history of stroke compared to the older group (P = 0.008). The standardized mean difference of six controlled confounders between the two groups before and after matching are shown in Supplementary Table 1. Additionally, 43 patients (97.7%) in the super-older group were American Society of Anesthesiologists grade 3 or 4, a proportion significantly higher than the 17 patients (38.6%) in the older group (P < 0.001). There were no significant differences between the two groups in other aspects such as gender, bile duct and bile duct stone status, acute cholangitis status, peripapillary diverticulum, and gallbladder stones (Table 1).

Table 1 Baseline data of patients with choledocholithiasis in the case and control groups before and after matching, n (%)

Baseline information	Before matching, case group (<i>n</i> = 45)	Before matching, control group (<i>n</i> = 383)	Before matching, <i>P</i> value	After matching, case group (<i>n</i> = 44)	After matching, control group (<i>n</i> = 44)	After matching, <i>P</i> value
Age ¹	92 (91, 94)	78 (73, 83)	< 0.001	92 (91, 94)	78.5 (72.25, 82)	< 0.001
Sex, male/female	14/31	185/198	0.029	14/30	16/28	0.688
Emergency ERCP	15 (33.3)	105 (27.4)	0.403	14 (31.8)	13 (29.5)	1.000
Accompanying underlying disease	37 (82.2)	296 (77.3)	0.451	36 (81.8)	29 (65.9)	0.189
Hypertension	30 (66.7)	254 (66.3)	0.963	29 (65.9)	25 (56.8)	0.523
Diabetes mellitus	5 (11.1)	94 (24.5)	0.043	5 (11.4)	7 (15.9)	0.774
Coronary heart disease	15 (33.3)	93 (24.3)	0.186	15 (34.1)	10 (22.7)	0.332
History of stroke	16 (35.6)	62 (16.2)	0.001	15 (34.1)	3 (6.8)	0.008
Alzheimer's disease	1 (2.2)	7 (1.8)	0.592	1 (2.3)	0 (0)	1.000
≥ 2 underlying diseases	21 (46.7)	157 (41)	0.465	20 (45.5)	13 (29.5)	0.189
Comorbidities						
History of malignant tumours of the biliopancreatic system	2 (4.4)	7 (1.8)	0.242	2 (4.5)	0 (0)	0.500
History of malignant tumours of the non-biliopancreatic system	2 (4.4)	37 (9.7)	0.381	2 (4.5)	2 (4.5)	1.000
Intrahepatic bile duct stones	8 (17.8)	22 (5.7)	0.007	8 (18.2)	8 (18.2)	1.000
Asymptomatic choledocho- lithiasis	3 (6.7)	3 (0.8)	0.017	3 (6.8)	0 (0)	0.250
Obstructive jaundice without cholangitis	0 (0)	16 (4.2)	0.326	0 (0)	1 (2.3)	1.000
Choledochal stones without cholangitis	4 (8.9)	64 (16.7)	0.175	4 (9.1)	8 (18.2)	0.344
Pancreatitis	10 (22.2)	68 (17.8)	0.463	10 (22.7)	6 (13.6)	0.388
Gallbladder stones	26 (57.8)	270 (70.5)	0.081	26 (59.1)	23 (52.3)	0.607
Acute cholangitis	41 (91.1)	316 (82.5)	0.142	40 (90.9)	35 (79.5)	0.227
Mild cholangitis	1 (2.2)	67 (17.5)	0.008	1 (2.3)	5 (11.4)	0.219
Moderate cholangitis	33 (73.3)	211 (55.1)	0.019	32 (72.7)	27 (61.4)	0.359
Severe cholangitis	7 (15.6)	38 (9.9)	0.364	7 (15.9)	3 (6.8)	0.344
History of cholecystectomy	6 (13.3)	47 (12.3)	0.838	6 (13.6)	11 (25)	0.267
Anticoagulant or antiplatelet drug use	12 (26.7)	68 (17.8)	0.147	12 (27.3)	5 (11.4)	0.092
Number of stones ¹	2 (1, 3)	1 (1, 2)	0.093	1.5 (1, 2.75)	1 (1, 2)	0.705
Maximum stone diameter ¹	12 (8.5, 18)	10 (5.7, 15)	0.045	12 (8.25, 18)	12 (9.25, 15)	0.416
Large stones (≥ 10 mm)	32 (71.1)	223 (58.2)	0.096	31 (70.5)	33 (75)	0.804
Multiple stones (≥ 2)	23 (51.1)	144 (37.6)	0.079	22 (50)	17 (38.6)	0.441
Multiple large stones	17 (37.8)	78 (20.4)	0.008	16 (36.4)	10 (22.7)	0.180
Largest diameter of common bile duct ¹	18 (14.5, 22)	15 (12, 20)	0.017	18 (14.25, 22)	16 (14, 20.75)	0.222
Dilated common bile duct (≥ 10 mm)	43 (95.6)	349 (91.1)	0.466	42 (95.5)	44 (100)	0.500
Peripapillary diverticulum	22 (48.9)	161 (42)	0.379	21 (47.7)	18 (40.9)	0.629
ASA status rating (3 or 4)	44 (97.8)	212 (55.4)	< 0.001	43 (97.7)	17 (38.6)	< 0.001

¹Evaluation of the statistical significance of non-normally distributed measures in the data before and after matching was based on the Mann-Whitney *U* test and the Wilcoxon signed rank test, expressed as M (P25, P75).

ERCP: Endoscopic retrograde cholangiopancreatography; ASA: American society of anesthesiology physical status classification system.

ERCP procedure information

After matching, the ERCP procedure success rate and stone retrieval rate of patients in the super-older group were slightly lower than those in the older group. In addition, the proportion of patients in the super-older group who used tracheal intubation for general anesthesia and postoperative transfer to ICU care was higher than the older group, but the difference was not statistically significant (P > 0.05, Figure 1). In comparison, the proportion of patients who used EPBD was significantly higher in the super-older group compared to the older group (P < 0.05, Table 2).

Post-ERCP complication rate, mortality rate, and recurrence rate

After matching, there were no significant differences in the overall complication rate, mortality rate, and recurrence rate between the two groups (P > 0.05). However, the complication rate, infection rate, perforation rate, device embedment rate, and mortality rate were slightly higher in the super-older group compared to the older group (Table 3, Figure 1).

DISCUSSION

Due to the scarcity of super-older patients, there is very limited research data on the effectiveness and safety of ERCP for the treatment of individuals with choledochal stones. Although complications related to biliopancreatic diseases have decreased with the iterative updating of medical technology, the associated surgical risks remain high for most older people with choledochal stones, especially the super-older. These patients often experience significantly deteriorated physical functions and are frequently accompanied by one or more underlying conditions, such as cerebrovascular or cardiovascular diseases or dementia [6,7]. The findings of this study indicated that there were no statistically significant differences between the super-older patients and older patients concerning the rates of successful ERCP procedures, stone extraction, complications, mortality, recurrence, and the duration of hospitalization. This indicates that ERCP is both effective and safe for treating choledocholithiasis in patients ≥ 90 years old.

Considering that non-ERCP treatments for choledocholithiasis are either associated with greater anesthetic risks - open choledochotomy and laparoscopic choledochotomy and exploration both require general anesthesia for routine endotracheal intubation and are significantly longer than ERCP treatments - or do not allow for the removal of stones and can only serve as a means of emergency biliary drainage (e.g., percutaneous hepatic puncture for choledochal duct drainage), or do allow for the removal of stones but require multiple stages of stone retrieval and a transabdominal wall fistula (e.g., percutaneous transhepatic choledochoscopic lithotripsy). It seems that ERCP may serve as a preferable treatment option for super-older patients with choledocholithiasis. However, this conclusion needs to be validated by a larger sample size of controlled clinical studies.

Several retrospective studies have investigated the efficacy and safety of ERCP in super-older patients. In terms of the effectiveness of ERCP, some of these previous studies report findings that differ slightly from the present study. A study by Saito et al[24] retrospectively compared the results of ERCP performed in 126 patients ≥ 90 years old with those of 569 patients (75-89 years) and showed that the rate of stone retrieval in super-older patients was significantly lower than in the younger patients (81% vs 94.9%, P < 0.001). In another study, Christoforidis $et\ al[25]$ investigated the feasibility of therapeutic ERCP in 33 patients aged ≥ 90 years and 272 younger patients (75-89 years of age) with choledocholithiasis, where the stone clearance rate was only 24.2% in super-older patients but 90.8% in the non-super-older patients (P <0.001). All of the above studies attributed the lower stone clearance rate in the super-older patients to the fact that these patients were more severely ill, in poorer physical condition, and had greater difficulty in stone clearance (more and larger bile duct stones). However, in terms of relieving biliary obstruction and keeping the bile duct open, there was no significant difference in the success rate of ERCP between the two age groups. In contrast, in the present study, although the success rates of ERCP procedures and the stone retrieval in the super-older patients were slightly inferior to those in the older group, there was no statistically significant difference between the two groups (P > 0.05), which differed from the results of the two studies mentioned above [24,25]. The reasons for this difference may be multifactorial. There may be potential differences in the demographic characteristics of different populations in different geographical areas. For individual patients, differences in the operator's experience and the treatment process can also have an impact on the outcomes. More importantly, differences in research methodologies can directly influence study results. In the present study, we used the method of propensity score matching, which can reduce bias by controlling for relevant confounders. Although the rate of stone retrieval in the super-older patients was significantly lower than that in the younger patients before matching [64.4% (29/45) vs 81.5% (312/383), P = 0.007], which was in complete agreement with the results of Saito et al[24] and Christoforidis et al[25], there was no significant difference in the rate of stone retrieval between the two groups after matching, even in the average number of ERCPs required for stone removal. However, the studies by Saito et al[24] and Christoforidis et al[25] did not control for confounders, which may explain the discrepancy between their results and those of the present study.

The relationship between recurrence rate and stone size, gallbladder stones, post-cholecystectomy, and common bile duct diameter was also investigated in this study. The findings indicated that there was no significant difference in recurrence rate between the two groups of patients, although it was higher in the older group (15.9% vs 9.1%). The study

Table 2 Endoscopic retrograde cholangiopancreatography procedures in patients with choledocholithiasis in the case and control groups, n (%)

	Case group (<i>n</i> = 44)	Control group (n = 44)	P value
Successful intubation	41 (93.2)	41 (93.2)	1.000
Stone removal	29 (65.9)	36 (81.8)	0.118
Incomplete stone removal	12 (27.3)	5 (11.4)	0.092
General anaesthesia	4 (9.1)	0 (0)	0.125
Laryngeal surface anaesthesia	40 (90.9)	44 (100)	0.125
Sphincter of Oddi preincision	7 (15.9)	6 (13.6)	1.000
Previous EST	7 (15.9)	11 (25)	0.424
Intraoperative EST	31 (70.5)	28 (63.6)	0.629
EPBD	27 (61.4)	8 (18.2)	< 0.001
Mesh basket lithotripsy	18 (40.9)	19 (43.2)	1.000
Mechanical lithotripsy	28 (63.6)	26 (59.1)	0.832
ENBD	38 (86.4)	34 (77.3)	0.424
ERBD	3 (6.8)	2 (4.5)	1.000
The average times of ERCP procedures required for stone removal ¹	1.5 (1, 2)	2 (1, 3)	0.204
One ERCP for stone removal	16 (36.4)	16 (36.4)	1.000
Two ERCPs for stone removal	11 (25)	15 (34.1)	0.503
Three ERCPs for stone removal	3 (6.8)	5 (11.4)	0.688
Number of days in hospital ¹	15 (11.25, 23.75)	14.5 (9.25, 20.75)	0.815

¹Evaluation of the statistical significance of non-normally distributed measures in the data before and after matching was based on the Mann-Whitney *U* test and the Wilcoxon signed rank test, expressed as M (P25, P75).

EST: Endoscopic sphincterotomy; EPBD: Endoscopic papillary balloon dilation; ENBD: Endoscopic nasobiliary drainage; ERBD: Endoscopic retrograde biliary drainage; ERCP: Endoscopic retrograde cholangiopancreatography.

Table 3 Complication rates in patients with choledocholithiasis in the case and control groups, n (%)					
	Case group (n = 44)	Control group (n = 44)	P value		
Postoperative pancreatitis	2 (4.5)	2 (4.5)	1.000		
Hyperamylasemia	8 (18.2)	6 (13.6)	0.727		
Infection	5 (11.4)	2 (4.5)	0.375		
Bleeding	1 (2.3)	1 (2.3)	1.000		
Digestive tract perforation	1 (2.3)	0 (0)	1.000		
Heart failure	2 (4.5)	2 (4.5)	1.000		
Cardiac infarction	0 (0)	2 (4.5)	0.500		
Device entrapment	1 (2.3)	0 (0)	1.000		
Death	3 (6.8)	0 (0)	0.250		

by Jeon et al[26] concluded that a larger common bile duct diameter may be one of the preventive factors for stone recurrence and that it should be monitored dynamically after ERCP. Additionally, studies by Park et al [27] and Nakai et al [28] claimed that stone size, gallbladder stones, and post-cholecystectomy are also risk factors for the recurrence of choledocholithiasis. However, none of the above risk factors associated with recurrence were significantly different between the two groups of patients in the present study. Given the scarcity of studies on the recurrence of choledocholithiasis in super-older patients (potentially related to their limited life expectancy), the reasons for the recurrence in these patients need to be further analyzed.

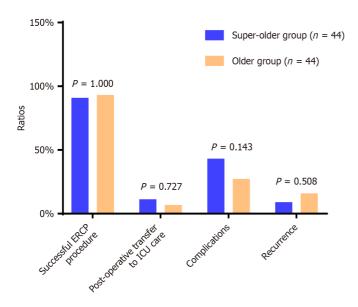


Figure 1 The comparison of safety and efficacy between the two groups of patients.

Previous research has indicated that there is no significant difference in complication and mortality rates associated with ERCP in super-older patients compared to younger patients[29-32]. The present study's findings align with this, as there were no significant differences in the complication and mortality rates between the two groups. However, these two rates were marginally elevated among the super-older patients. The slightly elevated complication rate observed in the super-older group may be attributed to a higher occurrence of hyperamylasemia and infections in this demographic compared with the older group. The former might be related to the fact that more patients in the super-older group had a history of stroke (which often required the use of antiplatelet agents) and, therefore, more EPBD, which is less likely to result in bleeding than EST but more likely to lead to hyperamylasemia or even pancreatitis[17], was used. This may be associated with the observation that patients within the super-older group presented a higher prevalence of comorbidities and exhibited a more deteriorated overall health status. Though there was no statistically significant difference in mortality rates observed between the two groups, all three deaths occurred in the super-older group. One patient died of sudden cardiac arrest after ERCP. One patient died of infectious shock due to a huge diverticular peripapillary papilla that prevented intubation. And one patient died of infectious shock due to a stone impaction in the middle of the common bile duct that prevented complete intubation. Previous literature reported that duodenal diverticula within 2-3 cm of the peripapillary diverticulum increases intubation difficulty [33,34]. The study by Chen et al [35] also concluded that peripapillary diverticula, stone incarceration in the common bile duct, and other reasons can lead to intubation difficulties or failure. Precision dissection or pancreatic duct occupancy can be considered to improve the success rate of intubation in such cases. We, therefore, speculate that although super-older age may not significantly increase mortality rates, the presence of conditions like peripapillary duodenal diverticula, stone incarceration, and other conditions that increase the difficulty of intubation, the mortality rate would still be higher due to their underlying diseases and poor physical conditions. This may render them unable to tolerate prolonged intubation or related procedures.

Regarding anesthesia for ERCP in super-older patients, previous research has yielded inconsistent findings. The study by Christoforidis $et\ al[25]$ showed that there was no significant difference in the rate of using tracheal intubation general anesthesia between the super-older group and the non-super-older group. In contrast, Sugiyama $et\ al[31]$ reported a significant difference in the rate of tracheal intubation general anesthesia utilization between the super-older and non-super-older groups (32% $vs\ 4\%$, P < 0.001) and concluded that the super-older patients with critical conditions or inability to cooperate intraoperatively may require tracheal intubation general anesthesia to ensure safety. In the present study, there was no significant difference between the two groups in the rate of tracheal intubation general anesthesia utilization and postoperative transfer to ICU care, but the super-older group did account for a slightly higher percentage of both. This is consistent, to some extent, with the findings of Christoforidis $et\ al[25]$ and Sugiyama $et\ al[31]$. Notably, the authors agree that tracheal intubation general anesthesia can better ensure the safety of some critically ill super-older patients because none of the four super-older patients who underwent general anesthesia with tracheal intubation in the present study had ERCP-related complications.

The limitations of this study are as follows. First, this study is retrospective in nature. While PSM was employed to mitigate the influence of confounding variables, it offered merely a partial level of control. Second, this study spanned from 2011 to 2023, during which some case records were missing. This makes it difficult to exclude potential biases associated with the missing data. Finally, this study was conducted at a single center and involved a relatively limited sample size. To address these limitations, future multicenter prospective studies with larger participant cohorts are necessary.

CONCLUSION

Therapeutic ERCP is effective and safe in super-older patients ≥ 90 years old with choledocholithiasis and is likely to be a preferred treatment for these patients. However, its therapeutic value needs to be further evaluated in future studies.

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FOOTNOTES

Author contributions: Wang L and Li ZY performed data collection and manuscript drafting; Wu F, Tan GQ, and Wang BL planned and designed the study; Wu F revised the manuscript for important intellectual content; and all authors issued final approval for the version to be submitted.

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Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment

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Bibliometric analysis on the top one hundred cited studies on gastrointestinal endoscopy

Jing Sui, Jian-Sheng Luo, Chao Xiong, Chun-Yong Tang, Yan-Hua Peng, Rui Zhou

Specialty type: Gastroenterology and hepatology

Provenance and peer review:

Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade A, Grade

В

Novelty: Grade A, Grade A Creativity or Innovation: Grade A,

Grade B

Scientific Significance: Grade A,

Grade A

P-Reviewer: Xia DM

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Abstract

BACKGROUND

Gastrointestinal endoscopy has been widely used in the diagnosis and treatment of gastrointestinal diseases. A great many of studies on gastrointestinal endoscopy have been done.

To analyze the characteristics of top 100 cited articles on gastrointestinal endoscopy.

METHODS

A bibliometric analysis was conducted. The publications and their features were extracted from the Web of Science Core Collection, Science Citation Index-Expanded database. Excel, Web of Science database and SPSS software were used to perform the statistical description and analysis. VOSviewer software and Map-Chart were responsible for the visualizations.

RESULTS

The top 100 cited articles were published between 1976 and 2022. The guidelines (52%) and clinical trials (37%) are the main article types, and average publication year of the guidelines is much later than that of the clinical trials (2015 vs 1998). Among the clinical trials, diagnostic study (27.0%), cohort study (21.6%), case series (13.5%) and cross-sectional study (10.8%) account for a large proportion. Average citations of different study types and designs of the enrolled studies are of no significant differences. Most of the 100 articles were published by European authors and recorded by the endoscopic journals (65%). Top journals in medicine, such as the *Lancet*, *New England Journal of Medicine* and *JAMA*, also reported studies in this field. The hot spots of involved diseases include neoplasm or cancer-related diseases, inflammatory diseases, obstructive diseases, gastrointestinal hemorrhage and ulcer. Endoscopic surgery, endoscopic therapy and stent placement are frequently studied.

CONCLUSION

Our research contributes to delineating the field and identifying the characteristics of the most highly cited articles. It is noteworthy that there is a significantly smaller number of clinical trials included compared to guidelines, indicating potential areas for future high-quality clinical trials.

Key Words: Gastrointestinal endoscopy; Guideline; Clinical trial; Bibliometric analysis; Quality of study

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Core Tip: The present study was conducted to analyze the characteristics of top 100 cited articles in this field. The primary findings include: (1) The guidelines (52%) and clinical trials (37%) are the main article types, and average publication year of the guidelines is much later than that of the clinical trials (2015 vs 1998); (2) Top journals in medicine, such as the *Lancet*, *New England Journal of Medicine* and *JAMA*, also reported studies in this field; and (3) The hot spots of involved diseases include neoplasm or cancer-related diseases, inflammatory diseases, obstructive diseases, gastrointestinal hemorrhage and ulcer. Researchers should attach importance to the unbalance of the highly cited guidelines and clinical trials on gastrointestinal endoscopy.

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INTRODUCTION

According to the International Agency for Research on Cancer, the global number of cancer diagnoses reached nearly 20 million in 2022, and cancers derived from esophagus, stomach and colorectum account for 17.1%[1]. Moreover, the global population with benign gastrointestinal diseases, such as gastroesophageal reflux and peptic ulcer, has been increasing[2, 3]. Gastrointestinal endoscopy is an effective tool for early diagnosis and treatment of gastrointestinal diseases[4,5]. In the past two centuries, digestive endoscopy has gone through the development process of early rigid endoscopy, semiflexible endoscopy, fiber endoscopy, electronic endoscopy and capsule endoscopy. Recently, artificial intelligence has been added to gastrointestinal endoscopy to help the endoscopists make diagnostic decisions[6,7]. An inspiring study published in the *Lancet Oncology* demonstrated that the application of artificial intelligence to gastrointestinal endoscopy has higher accuracy than ordinary endoscopists in cancer detection[8]. Absolutely, remarkable achievements have been made in the field of gastrointestinal endoscopy and there are a large number of key studies that guide clinical practice. However, the characteristics of these studies have not been elucidated.

To be cited is the most common, direct and effective influence of a study, and it's also the embodiment of recognition in the academic field. Therefore, it is necessary to analyze the highly cited articles. The typical features of these articles can be summarized in two aspects: The quality and visibility[9]. Although there are various motivations for citing particular articles, the primary one is still that the target papers are cognized by the authors and can be cited to support opinions. In this course, quality of the articles may be a priority in most circumstances. Another main point is the visibility of publications. Generally, studies published in top journals or written by well-known professors can gain more awareness and, thereafter, more citations[10,11]. Consequently, these articles may become more popular. In other words, popularity of the authors or journals would raise the evaluation of study quality. However, it is not always this way. In some academic areas, such as gastric diseases, articles published in journals with low impact factor (IF) can be highly cited[12].

Bibliometrics entails the quantitative analysis of scientific literature. Previous efforts have been made to compile and publish lists of the most frequently cited articles in various fields and journals. For instance, an early bibliometric analysis summarized the characteristics of highly cited clinical studies on digestive diseases[13]. In this paper, clinical trials account for 84% of the top 100 articles, whereas studies propose or refine relevant methodology make up 16%. However, our review of the literature indicates a lack of dedicated bibliometric analysis for the highly cited articles on gastrointestinal endoscopy at present. In our study, we intend to demonstrate the global trend and characteristics of the 100 most cited articles focused on gastrointestinal endoscopy.

MATERIALS AND METHODS

Eligibility of the publications

The target of this study is the studies that focus on gastrointestinal endoscopy. Thus, synonyms for gastrointestinal endoscopy should present in the title, be the main objects or tools. Besides, study types other than research paper and review paper (including systematic review and meta-analysis) were not taken into analysis, such as case report, letter, editorial, *etc*.

Literature acquisition

The publications were searched in the Web of Science Core Collection (WoSCC), Science Citation Index-Expanded (SCI-EXPANDED) database on April 11, 2024. Gastrointestinal endoscopy, intestinal endoscopy, gastric endoscopy, digestive system endoscopy and gastroenterological endoscopy were combined by a Boolean operator "OR". The document types were restricted to "article" and "review article". Then, the records were sorted by citations in a descending order. The investigators reviewed these records and determined the eligibility of the studies. Finally, the top 100 articles were filtered out.

Feature extraction

The 100 records were exported to a plain text file. Basic bibliometric data were automatically extracted from WoSCC. The data were saved as an Excel file. Afterwards, two investigators manually obtained some other parameters, including IF, category rank and quartile of the journals, study type and study design.

Feature analysis

Basic bibliometric analyses, such as the publication number and citations of the authors, institutions and countries/regions, and different ages, were performed using Excel and VOSviewer. The keywords were classified and counted by VOSviewer. We selected the keywords related to diseases and operations respectively. Hence, two sets of keywords were constructed and they were arranged by the publication year. Visualization of keywords was conducted using VOSviewer, while visualization of global distribution of the articles was based on MapChart, an online tool. Manually extracted data, including IF, category rank and quartile of the journals, study type and study design, were analyzed with descriptive statistics. Average citations of different study type and study design were compared using one-way analysis of variance test or independent *t*-test, and the pairwise comparisons were performed using LSD test *via* SPSS 26.0. Correlation analysis was applied to determine the relationship between IF and average citations. The significance level was set as 0.05.

RESULTS

Publication trend at different ages

In the WoSCC SCI-EXPADED database, the top 100 cited articles were published between 1976 and 2022. The citations ranged from 134 to 755, with a mean of 268, and a median (inter-quartile) of 219 (167, 317). There are 7 publication years in which the publication number was 5 or over. The most productive publication year was 2017 (n = 8), followed by 2012 (n = 7), 2020 (n = 7), 2019 (n = 6), 2010 (n = 5), 2014 (n = 5), and 2016 (n = 5). Generally, the publications increased at different ages (time interval: 5 years), and over a half of the highly cited articles were published between 2010 and 2020 (Table 1).

Study type analysis

The study types of the top 100 cited articles included clinical trial (37.0%), review (6.0%), meta-analysis (3.0%), guideline (52.0%) and database analysis (2.0%) (Table 2). Interestingly, 90.4% of the guidelines were issued by the European Society of Gastrointestinal Endoscopy, and another 2 organizations were the American Society for Gastrointestinal Endoscopy and the Japan Gastroenterological Endoscopy Society. Average publication year of the clinical trials was 1998, while it was 2015 for the guidelines (Table 2). Average citations of the meta-analysis studies were the highest (n = 287), followed by the guidelines (n = 276), clinical trials (n = 265), reviews (n = 246) and database studies (n = 151) (Table 2). However, the differences in average citations of different study types were not significant (p = 0.785).

Study design analysis

According to the JAMA classifications for clinical trials [14], the 37 clinical trials were divided into 9 categories, including survey study (n = 2, 5.4%), randomized controlled trial (n = 2, 5.4%), quality improvement study (n = 2, 5.4%), parallel-design trial (n = 3, 8.1%), diagnostic study (n = 10, 27.0%), cross-sectional study (n = 4, 10.8%), comparative effectiveness research (n = 1, 2.7%), cohort study (n = 8, 21.6%), and case series (n = 5, 13.5%) (Table 3). Average citations of the cross-sectional study studies were the highest (n = 327), followed by the diagnostic studies (n = 288) and case series (n = 276) (Table 3). However, the differences of average citations of different study designs were not significant (n = 12, 32.4%). Average citations of the single-center studies were comparable with those of the multicenter-studies (n = 12, 32.4%). Average citations of the single-center studies were comparable with those of the multicenter-studies (n = 12, 32.4%).

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Table 1 The pu	Dification trend	a of the top Tuu (citeo articles a	t different ades

Publication year	Publication number	Total citations	Average citations
1976-1980	2	737	369
1981-1985	3	549	183
1986-1990	6	1029	172
1991-1995	7	1855	265
1996-2000	4	741	185
2001-2005	12	4860	405
2006-2010	11	2166	197
2011-2015	23	6532	284
2016-2020	29	7746	267
2021-2022	3	599	200

Table 2 Publication trend of different study types							
Study type	Publication number	Total citations	Average citations	Average publication year			
Clinical trial	37	9818	265	1998			
Review	6	1474	246	2007			
Guideline	52	14359	276	2015			
Database study	2	302	151	2009			
Meta-analysis	3	861	287	2007			

Table 3 Publication trend of different study designs							
Study design	Publication number	Total citations	Average citations	Average publication year			
Survey study	2	514	257	1993			
Randomized controlled trial	2	405	203	1994			
Quality improvement study	2	301	151	2000			
Parallel-design trial	3	809	270	2006			
Diagnostic study	10	2883	288	2003			
Cross-sectional study	4	1308	327	1984			
Comparative effectiveness research	1	171	171	1984			
Cohort study	8	2060	258	1998			
Case series	5	1382	276	1998			

Analyses of the authors, institutions and countries/regions

The 100 articles were signed by 874 authors of 493 affiliations from 43 countries or regions. Thirty-one authors published 5 papers or over. Table 4 shows the top 10 authors in terms of publication number. Hassan Cesare was the most productive author (n = 27), followed by Dumonceau Jean-Marc (n = 23) (Table 4). The citations of Hassan Cesare, Dumonceau Jean-Marc and Dinis-Ribeiro Mario were above 5000 (n = 8102, 6650, and 5085, respectively). Ninety percent of the top 10 authors had a European nationality. Fifty-nine affiliations created at least 5 articles. Table 5 displays the top 10 prolific institutions. University of Amsterdam (n = 28) and IRRCCS Policlinico Gemelli (n = 27) took the leading position. Ten (90.9%) of them were European countries. Twenty-three countries or regions produced 5 publications or over. Most of the countries or regions belonged to Europe (Figure 1). Moreover, almost all prolific countries or regions, except the United States and Argentina, were concentrated in Europe (Figure 1).

Journal analysis

In total, 24 journals documented the 100 papers, 16 (66.7%) of them had only 1 publication (Table 6). The Endoscopy (50

Table 4 Top 10 authors in terms of publication number						
Author	Publication number	Total citations	Institution	Country		
Hassan Cesare	27	8102	Nuovo Regina Margherita Hosp	Italy		
Dumonceau Jean-Marc	23	6650	Gedyt Endoscopy Ctr	Argentina		
Van Hooft Jeanin E.	14	3621	Leiden Univ	Netherlands		
Dinis-Ribeiro Mario	14	5085	Portuguese Institute of Oncology	Portugal		
Dumonceau Jean-Marc	12	3591	Charleroi Univ Hosp	Belgium		
Vanbiervliet Geoffroy	9	2119	CHU Nice	France		
Bisschops Raf	8	2249	Univ Hosp Leuven	Belgium		
Tringali Andrea	8	2225	Fdn Policlin Univ A Gemelli IRCCS	Italy		
Spada Cristiano	8	2398	Fdn Poliambulanza	Italy		
Ponchon Thierry	8	3125	CHU Lyon	France		

Table 5 Top 10 institutions in terms of publication number						
Institution	Publication number	Total citations	Country			
University of Amsterdam	28	7717	Netherlands			
IRRCCS Policlinico Gemelli	27	6995	Italy			
Gedyt Endoscopy CTR	20	6322	Argentina			
Academic Medical Center Amsterdam	19	5114	Netherlands			
Poliambulatorio Nuovo Regina Margherita	17	5637	Italy			
Univ Libre Bruxelles	15	4217	Belgium			
Aix Marseille University	14	3943	France			
University of Oslo	14	3865	Norway			
Centre of Postgraduate Medical Education	13	3883	Poland			
Maria Sklodowska-Curie National Research Institute of Oncology	12	3619	Poland			
University of Geneva	12	3215	Switzerland			

publications) was the leading journal in this field, followed by Gastrointestinal Endoscopy (11 publications) (Table 6). It must be noted that 80.4% of the publications in Endoscopy are guidelines and clinical trials account for 12%. Most of the journals are top journals, the Lancet, New England Journal of Medicine and JAMA included (Table 6). The average IF (2022) is 30.2, and the median is 9.5 (Table 6). These journals had stable performance of IF in the latest 5 editions. The average 5year IF is 24.6, with a median of 14.3 (Table 6). Eighteen (75.0%) journals were located in the first quartile (Q1) of the categories, 5 (20.8%) in the second (Q2) and 1 (4.2%) in the fourth (Q4) (Table 6). Correlation analysis indicated that the average citations was not correlated to the IF (Pearson correlation = 0.146, P = 0.496).

Keywords analysis

We analyzed 2 sets of keywords. The one is related to the diseases. As shown in Figure 2, gastrointestinal endoscopy was most frequently conducted to detect neoplasms or cancer-related diseases in the top 100 articles. Inflammatory diseases (pancreatitis, esophagitis, inflammatory bowel disease and gastritis), obstructive diseases (strictures, stones and obstructions), gastrointestinal hemorrhage and ulcer were also highly concerned topics (Figure 2). Other diseases, such as coronary artery disease, anemia and pneumonia, were mentioned in the top 100 studies (Figure 2). The other set of keywords is associated with the application of gastrointestinal endoscope. Routine gastrointestinal endoscopy with various endoscopes had the most occurrence, followed by endoscopic surgery, endoscopic therapy, stent placement and sedation (Figure 3). Other high-frequency operations included endoscopic retrograde cholangiopancreatography, bowel preparation and drainage (Figure 3).

DISCUSSION

As far as we know, this is the first bibliometric analysis to elucidate the characteristics of the top 100 cited publications

Table 6 Characteristics of	iournale recording	a the 100 articles
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Source title	IF, 2022	IF, 5- year	Category rank	Quartile	Publications	Citations	Average citations
Endoscopy		9.6	6	Q1	50	13907	278
Gastrointestinal Endoscopy		7.9	16	Q1	11	3389	308
Gut	24.5	25.2	5	Q1	7	1627	232
American Journal of Gastroenterology	10.2	11.5	10	Q1	6	1592	265
New England Journal of Medicine	158.5	115.7	2	Q1	4	706	177
Annals of Internal Medicine	39.2	35.3	6	Q1	2	528	264
Clinical Gastroenterology and Hepatology	12.6	11.4	8	Q1	2	708	354
Digestive Endoscopy		5.3	16	Q1	2	490	245
Annual Review of Biomedical Engineering	9.7	18.9	9	Q1	1	140	140
Clinical Microbiology Reviews	36.8	37.4	3	Q1	1	305	305
European Radiology	5.9	5.5	16	Q1	1	144	144
Gastroenterology	29.4	25.8	3	Q1	1	699	699
Jama-Journal of The American Medical Association	120.7	81.4	3	Q1	1	599	599
Journal of Clinical Pathology	3.4	3.1	28	Q2	1	136	136
Journal of Gastroenterology and Hepatology	4.1	4	38	Q2	1	187	187
Journal of Pediatric Gastroenterology and Nutrition	2.9	3.4	42	Q2	1	140	140
Lancet	168.9	118.1	1	Q1	1	138	138
Lancet Oncology	51.1	41.6	4	Q1	1	209	209
Photochemistry and Photobiology	3.3	3.2	28	Q2	1	281	281
Scandinavian Journal of Gastroenterology	1.8	2.2	86	Q4	1	283	283
Scientific Data	9.8	10.8	11	Q1	1	158	158
Surgical Endoscopy and Other Interventional Techniques	3.1	3.5	50	Q1	1	135	135
Surgical Endoscopy-Ultrasound and Interventional Techniques	3.1	3.5	50	Q1	1	149	149
World Journal of Gastroenterology	4.3	5.3	33	Q2	1	164	164

IF: Impact factor.

focused on gastrointestinal endoscopy. Our results show a typical trend in the document types of the 100 publications in this field. Generally, the guidelines and clinical trials are the main article types. However, in recent years, the guidelines with high citations were intensively published, while very few clinical trials rank top 100 in terms of citations. The first guideline among the top 100 articles on gastrointestinal endoscopy provides recommendations on conscious sedation and monitoring[15]. This guideline was published in 2003 by the American Society for Gastrointestinal Endoscopy. The first clinical trial on sedation and gastrointestinal endoscopy in the WoS database was published in 1976 in the British Medical Journal [16]. In this study, diazepam was the sedative. Midazolam was proved to be preferred over diazepam by patients in 1983[17]. Then, propofol was used in gastrointestinal endoscopy and had advantages in rapid recovery over midazolam, but reduced patient satisfaction[18]. However, with the increasing number of endoscopic cases, it is vital to provide rapid-onset and rapid-recovery sedation. Therefore, propofol became the primary sedative for gastrointestinal endoscopy. Recently, remimazolam has been recommended for gastrointestinal endoscopy [19,20]. The efficiency and safety of ciprofol have also been demonstrated [21,22]. Anesthesiologists now have many choices to induce sufficient and safe sedation for gastrointestinal endoscopy. The latest highly cited guideline gives detailed strategies of endoscopic submucosal dissection for superficial tumors of the digestive tract[23]. Among the 52 highly cited guidelines in this field, this is the third update of edition 2015 and edition 2019[24,25], which indicates the early diagnosis and treatment of gastrointestinal neoplasms.

The first clinical trial among the top 100 articles on gastrointestinal endoscopy, published in 1976, evaluated the value of emergency upper gastrointestinal fiber-endoscopy and modified Sengstaken tube for patients with portal hypertension and varicosity[26]. According to the keywords analysis of this study, gastrointestinal hemorrhage is one of the hot spots in this field. There are 16 studies focused on gastrointestinal hemorrhage in the 100 articles. The most popular one,

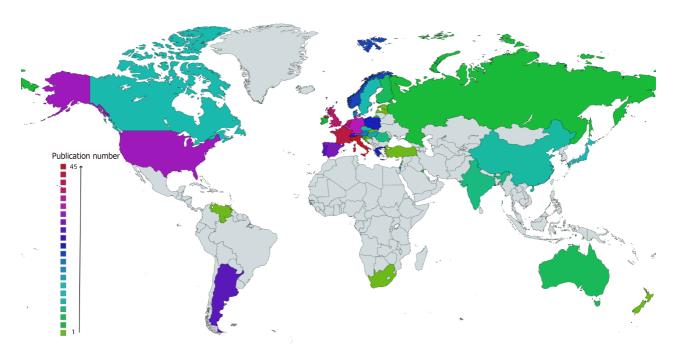


Figure 1 Global distribution of the 100 articles.

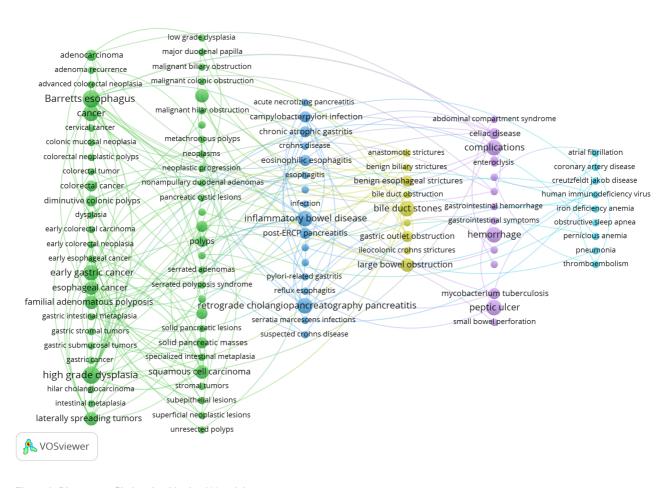


Figure 2 Disease profile involved in the 100 articles.

indicating the value of capsule endoscopy for obscure gastrointestinal hemorrhage, was cited 699 times[27]. The most cited clinical trial on gastrointestinal endoscopy, however, is about the influence of bowel preparation on colonoscopy [28]. This study shows that cleansing is highly correlated to quality, difficulty and speed of colonoscopy and that hospitalized patients and patients with higher levels of comorbidities had lower cleanliness quality. Thus, a guideline for bowel preparation was published the next year (2006) and became one of the top 100 cited articles[29]. Another two updates

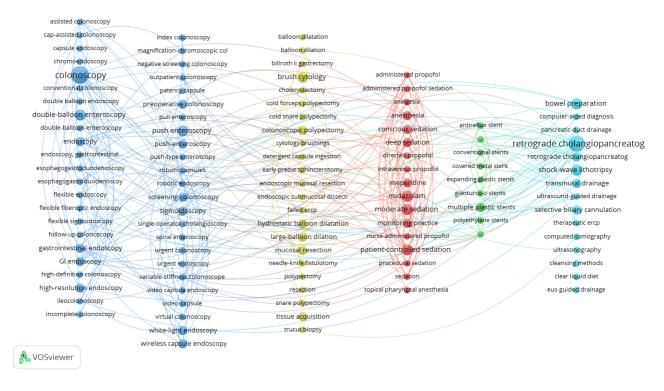


Figure 3 Operations and procedures involved in the 100 articles.

(2013 and 2019) of guidelines for bowel preparation also raised many citations [30,31].

Since clinical trials are the basis of meta-analyses and guidelines, the quality of clinical trials determines the reliability of meta-analyses and guidelines. Mismatch of the number of guidelines and clinical trials in the top 100 must be paid attention. Many recommendations in the guidelines have low-level evidence, even in the most cited guideline [24]. For instance, "If the horizontal margin is positive and no other high risk criteria are met, endoscopic surveillance/re-treatment is an option" and "European Society of Gastrointestinal Endoscopy recommends regular endoscopic follow-up after excision/ablation of Barrett esophagus-associated high-grade dysplasia or mucosal cancer, but more research is needed to determine the appropriate short and long intervals" are strongly recommended, but the evidence level is low[24]. Thus, further clinical trials should be conducted to improve the weaknesses.

There may be some reasons for the different citations between guidelines and clinical trials. Constructing a guideline usually includes raising problem, reviewing literature, evaluating research evidence, expert consensus, drafting, external review and revisions. Therefore, guidelines are considered as the golden standards in disciplines and naturally are more likely to be cited. Researchers in this field should pay more attention to the quality rather than the number of studies. Despite the various factors influencing citation, basic features of high-quality trials, such as focusing on the clinical problems, rational study design, standardized study procedure and scientific result interpretation, should be more considered.

There are some limitations in this bibliometric analysis. In order to retrieve well-recognized articles, we did the search in WoSCC SCI-EXPANDED database. This may omit some publications and impact cited times and ranks of the studies. However, the SCI-EXPANDED is a well-known database that records high-quality English articles, which is in accordance with our research target. The choice of time interval (5 years) to count the number of publications and citations has no scientific basis. We referred to the WoS system where a 5-year IF is used to evaluate journals. Besides, we did not merge synonyms. So, there are some repeated keywords in Figure 2 and Figure 3. Nevertheless, it does not impact the results.

CONCLUSION

In the present study, we analyzed the characteristics of the 100 most frequently cited articles on gastrointestinal endoscopy. Authors from Europe made significant contributions to the 100 hot papers. Journals that recorded the articles have high IF. The hotspots are endoscopic diagnosis and treatment of tumor-related diseases. The guidelines are the most popular and recognized articles in this field, followed by clinical trials. The differences of citations among study types and designs are not significant for the top 100 articles. However, highly cited clinical trials are rare for more than a decade. High-quality clinical trials are urgently needed to support the guidelines, and further, the clinical practice.

FOOTNOTES

Author contributions: Sui J, Luo JS, Peng YH, and Zhou R conceived and designed the study; Sui J and Luo JS participated in data processing and statistical analysis, they contributed equally as co-first authors; Sui J, Luo JS, Xiong C, Tang CY, and Peng YH drafted the manuscript; Sui J, Luo JS, Xiong C, Tang CY, and Peng YH contributed to data analysis and interpretation; Zhou R supervised the review of the study; Peng YH and Zhou R contributed equally as co-corresponding authors; and all authors seriously revised and approved the final manuscript.

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SCIENTOMETRICS

Insights into anesthesia administration for elderly individuals undergoing painless gastroenteroscopy: A bibliometric study

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Abstract

BACKGROUND

Administering anesthesia to elderly patients undergoing gastroenteroscopy necessitates careful attention due to age-related physiological changes and an increased risk of complications.

To analyze the research trends in anesthesia management for elderly patients undergoing gastroenteroscopy.

METHODS

We performed a literature search using the Web of Science database to identify articles published between 2004 and 2023. Bibliometric and visual analyses were conducted using CiteSpace, R, and VOSviewer to explore the current research landscape of anesthesia administration in painless gastroenteroscopy for elderly patients and to identify future research directions by examining trends and emerging hotspots in this domain.

RESULTS

A total of 800 articles were examined, revealing a rising trend in annual publication counts. The United States led with 181 articles, followed by China with 112, collectively contributing over 35% of the studies among the top ten countries. The majority of publications appeared in the United States journals, with the top three being Gastrointestinal Endoscopy [impact factor (IF) = 7.7, H-index = 26], Digestive Diseases and Sciences (IF = 3.1), and Endoscopy (IF = 9.3). Six primary research clusters were identified: Obstructive sleep apnea and airway management, surveillance and risk factors, colorectal cancer examination and treatment, sedation and safety of propofol and midazolam, patient satisfaction, and mortality and complications. These findings underscore the pivotal focus areas in anesthesia for elderly patients undergoing gastroenteroscopy.

CONCLUSION

A comprehensive understanding of current research trends and hotspots will aid anesthesiologists in developing more evidence-based practices, thereby improving the safety and outcomes for elderly patients undergoing gastroenteroscopy.

Key Words: Anesthesia; Elderly; Gastroenteroscopy; Bibliometric; CiteSpace; VOSviewer

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Core Tip: Anesthesia management for elderly patients undergoing gastroenteroscopy is complex due to physiological changes and increased risks of complications. This study offered a bibliometric analysis of 800 articles (2004-2023), identifying key research trends. The United States and China were the leading contributors. Key areas for future research included: (1) Sedation safety with propofol and midazolam; (2) Airway management with a focus on obstructive sleep apnea; (3) Risk factors for complications and mortality; (4) Colorectal cancer examination and treatment; and (5) Patient satisfaction. These insights will guide anesthesiologists toward more evidence-based practices for improved safety and outcomes in elderly patients.

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INTRODUCTION

Painless gastroenteroscopy is a vital medical procedure for diagnosing and treating a range of gastrointestinal disorders. Its popularity is on the rise, with millions of procedures conducted globally each year. Effective anesthesia management is paramount to ensuring patient comfort and safety, especially in elderly patients who face heightened risks of complications due to age-related physiological changes [1-4]. Despite advancements in anesthetic techniques, elderly patients continue to experience significant morbidity and mortality[5].

Given these considerations, the imperative to develop optimal anesthesia management strategies for the elderly population undergoing painless gastroenteroscopy is more pressing than ever. Bibliometric analysis serves as a robust tool for systematically mining, organizing, and interpreting relevant publications. This method enables the identification of research trends, knowledge gaps, and promising avenues for further investigation [6].

Our study aimed to employ bibliometric analysis to collate and synthesize existing evidence on anesthesia administration for elderly patients undergoing painless gastroenteroscopy. By systematically reviewing and analyzing a comprehensive array of the literature, we sought to elucidate current trends and prospective directions in this domain. The insights derived from our study will inform clinical decision-making, refine anesthesia practices, and ultimately enhance patient outcomes within this vulnerable demographic.

MATERIALS AND METHODS

Data source and search strategy

The search procedure followed the sequence outlined in Figure 1. A comprehensive search of the Web of Science database was performed to identify articles focusing on elderly patients undergoing painless gastroenteroscopy from 2004 to 2023. Original and review articles published in English were included. The search terms were typescript (TS) = ("gastroscopic" OR "gastroscopy" OR "gastroscopies" OR "colonoscopy" OR "colonoscopies" OR "colonoscopic" OR "upper endoscopy" OR "lower endoscopy") AND TS = [("general anesthesia") OR ("general anaesthesia") OR ("general anesthesia") OR ("general anaesthesi")] OR [("Conscious Sedation") OR ("minimal Sedation") OR (anxiolysis) OR ("Sedation, Moderate") OR ("Moderate Sedation") OR ("Sedation, Conscious") OR ("Sedation, deep") OR ("Painless") OR ("sedation") OR ("sedative") OR ("sedated")] AND TS = ("elderly" OR "aged" OR "old people" OR "old-timer" OR "oldie").

Bibliometric analysis

A descriptive statistical analysis of annual outputs and growth trends was conducted using Microsoft Office Excel 2017 (Microsoft, Redmond, WA, United States). The Bibliometrix package in R (version 4.2.1) was employed for bibliometric analysis and data visualization. VOSviewer (version 1.6.19) was used to create visualization networks for countries, institutions, authors, and keywords. The co-occurrence analysis in VOSviewer clustered keywords, assigning color codes to highlight emerging research trends.

Identification of studies via Web of Science Records identified from Web of Science Core Collection: ("gastroscopic" OR Identification "gastroscopy" OR "gastroscopies" OR "colonoscopy" OR "colonoscopies" OR "colonoscopic" OR "upper endoscopy" OR "lower endoscopy") AND TS = [("general anesthesia") OR ("general anaesthesia") OR ("general anesthesi") OR ("general anaesthesi")] OR [("Conscious Sedation") OR ("minimal Sedation") OR (anxiolysis) OR ("Sedation, Moderate") OR ("Moderate Sedation") OR ("Sedation, Conscious") OR ("Sedation, deep") OR ("Painless") OR ("sedation") OR ("sedative") OR ("sedated")] AND TS = ("elderly" OR "aged" OR "old people" OR "old-timer" OR "oldie") (n = 977) Excluded non-English and non-between Literature were identified January 1, 2024 to December 31, 2023 (n = 845)(n = 132)Excluded: Proceeding paper (n = 25) Meeting abstract (n = 12) Early access (n = 3)Letter (n = 2)Biographical-item (n = 1)Editorial material (n = 1)Retracted publication (n = 1)Included 800 literature were identified: Articles (n = 781) and review articles (n = 19)

Figure 1 Flowchart illustrating the search strategy.

The journal citation report 2023 supplied essential data, such as the journal's impact factor, H-index, and category ranking quartiles[7]. CiteSpace software (version 6.2.R3) was employed to detect keywords and references with significant citation bursts and to create co-cited reference and cluster visualization networks. In the CiteSpace network, each entity is depicted as a node, where larger nodes represent more frequent occurrences[8]. Furthermore, centrality analysis indicated that nodes with higher centrality scores are more influential[9].

RESULTS

Overview of publications

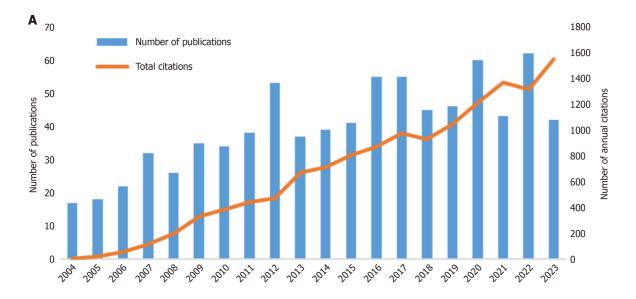
In total, 800 publications regarding anesthesia for painless gastroenteroscopy in elderly individuals were identified. These works have collectively accumulated 13497 citations, resulting in an average of 18.90 citations per article. The citation rate highlights the considerable influence of research in this area. Moreover, the H-index for this body of work was determined to be 27, indicating significant academic recognition and contribution to the field.

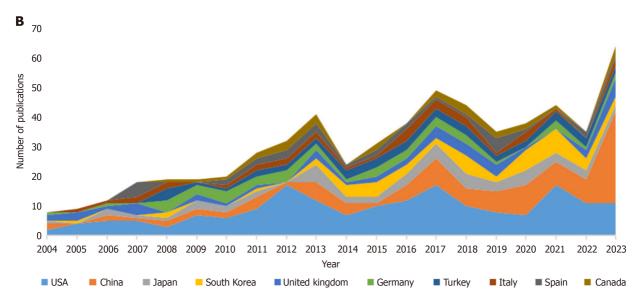
Annual outputs and growth trends

Research on the anesthetic management for painless gastroenteroscopy in elderly patients has seen a marked rise in outputs and citations between 2004 and 2023 (Figure 2A). The number of yearly publications increased from 17 in 2004 to 42 in 2023, while annual citations surged from 4 to 1551 over this period. Notably, since 2012, there has been a pronounced upward trend in publications, reflecting intensified global focus and rapid advancements in professional theories. Regarding geographical distribution, the United States has emerged as the leading in research contributions, followed by China, Japan, South Korea, and several other nations (Figure 2B). China's contribution in 2022 was particularly noteworthy, likely due to its rapidly aging population and the consequent emphasis on addressing the healthcare needs of the elderly[10].

Distribution of countries/regions and institutions

Figure 2C presents a network visualization of international collaborations. The top ten contributing countries are summarized in Supplementary Table 1, with the United States leading with 181 publications, followed by China (112), Japan (52), South Korea (50), and the United Kingdom (44). Collectively, the United States and China accounted for over 35% of the total publications from these leading nations. The centrality score, a measure of the importance of network nodes, assigned the highest value of 0.39 to the United States. In terms of paper quality, as measured by citation count and H-index, publications from the United States demonstrated the highest performance with 4093 citations and an H-







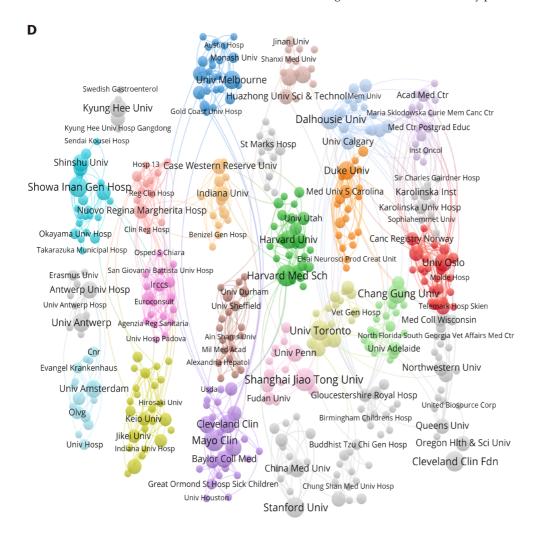


Figure 2 Trends in annual publication outputs and collaborations among countries, regions, and institutions. A: The total number of publications and citations regarding anesthetic management for painless gastroenteroscopy in elderly individuals from 2004 to 2023; B: Growth patterns of the top 10 countries; C: Contributions of countries/regions; D: Contributions of institutions to publications.

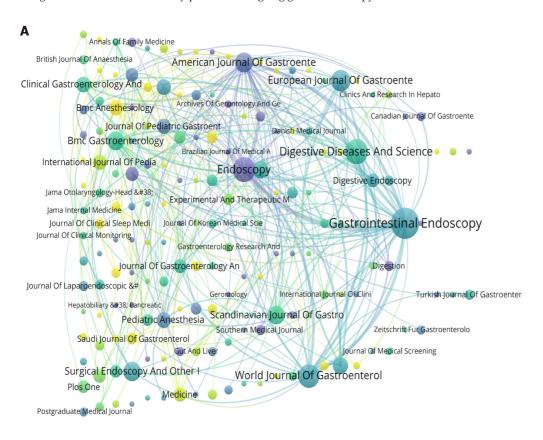
index of 48. Germany, despite having the sixth-highest publication volume (42 articles), ranked second in citations (1727) and H-index (31). China, with 1523 citations and an H-index of 35, was third, indicating substantial output but fewer highly impactful papers relative to its overall contribution. Figure 2D presents the network of institutional collaborations. Among the top ten institutions, Harvard University ranked highest with 17 articles, followed by the Cleveland Clinic Foundation with 16 and the United States Department of Veterans Affairs with 14 (see Supplementary Table 2). Of the ten most prolific institutions, seven were based in the United States, while the remaining three included the University of Antwerp in Belgium, Shanghai Jiao Tong University in China, and the University of Toronto in Canada.

Journals publishing research

In the last 20 years, a total of 250 journals have played a role in the research on anesthesia for painless gastroenteroscopy (Figure 3A). The top ten most prolific journals in this field, predominantly from the United States, are summarized in Supplementary Table 3. These top 10 journals accounted for 28.99% (207 out of 714) of the articles included in our analysis. Leading the publication volume was Gastrointestinal Endoscopy (H-index = 26; impact factor = 7.7), followed by Digestive Diseases and Sciences (impact factor = 3.1) and Endoscopy (impact factor = 9.3). As per the journal citation reports (JCR) for 2022, these three journals were classified as Q1/Q2. The Q1 category included Gastrointestinal Endoscopy, Endoscopy, American Journal of Gastroenterology, and Surgical Endoscopy and Other Interventional Techniques. Those in Q2 included Digestive Diseases and Sciences and World Journal of Gastroenterology, while the Journal of Clinical Gastroenterology was ranked in Q3.

Contributions of authors

CiteSpace was employed to visualize the contributions of authors in this field (Figure 3B), revealing a total of 4303 authors who have published articles on this topic. Supplementary Table 4 lists the top 10 researchers with the highest number of publications. Leading the list are Hassan C and Bretthauer M, each with 7 articles and 178 citations. They are followed by Amornyotin S and Capasso R, each with 6 articles and 260 citations. The elevated citation counts signify the quality and impact of these authors' works, highlighting their important contributions to the field.



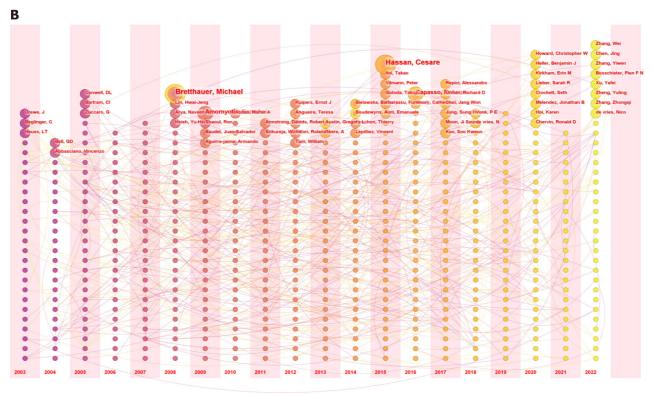
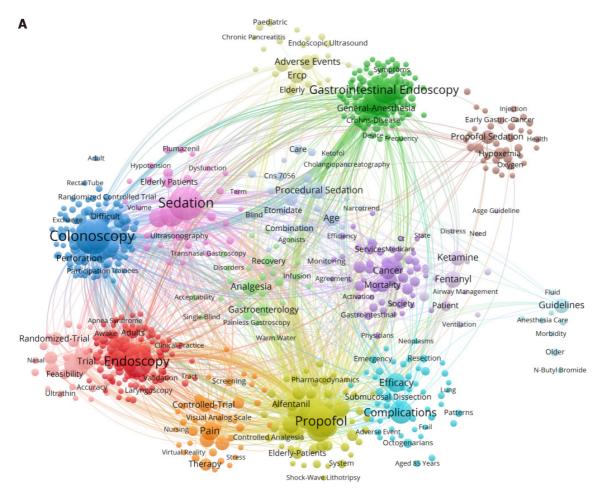
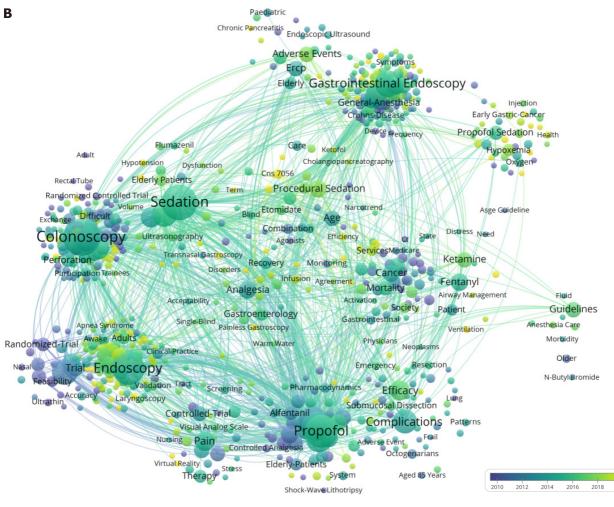


Figure 3 Journals publishing research and contributions of authors. A: Journals publishing papers; B: Joint mapping of high-producing authors on anaesthetic management for painless gastroenteroscopy in elderly individuals from 2004-2023.

Keywords

Cluster analysis of keyword co-occurrence related to research hotspots: In this study, VOSviewer software was employed to analyze the titles and keywords of 800 relevant publications. Figure 4A illustrates the division of the map into 15 clusters, encompassing a total of 712 keywords. Notably, 104 keywords appeared more than 10 times, with the top 10 keywords listed in Supplementary Table 5. The most frequently occurring keywords were "colonoscopy" (237 occurrences), "sedation" (210), "propofol" (173), "endoscopy" (163), "midazolam" (119), and "conscious sedation" (107),





Top 25 keywords with the strongest citation bursts

Keywords	Year				2003 - 2022
upper gastrointestinal endoscopy	2003	8.12	2003	2008	
tolerance	2003				
gastroscopy	2003	3.66	2003	2007	
randomized trial	2004	3.82	2004	2012	
general anesthesia	2005	5.51	2005	2010	
premedication	2005	3.8	2005	2010	
meperidine	2006				
gastroenterologist	2006	5.13	2006	2012	
registered nurse	2006				
outpatient colonoscopy	2006	3.48	2006	2012	
conscious sedation	2003				
difficult	2007	3.71	2007	2008	
pain	2008	5.24	2008	2015	
randomized controlled trial	2008	3.72	2008	2010	
deep sedation	2009	3.59	2009	2014	
metaanalysis	2010	4.38	2010	2017	
controlled trial	2011	4.69	2011	2016	
surveillance	2011				
propofol sedation	2012	3.83	2012	2016	
risk factor	2014	3.6	2014	2022	
risk	2003	3.5	2015	2022	
gi endoscopy	2007	5.15	2017	2018	
adenoma detection rate	2017				
management	2007	6.5	2018	2022	
obstructive sleep apnea	2016				

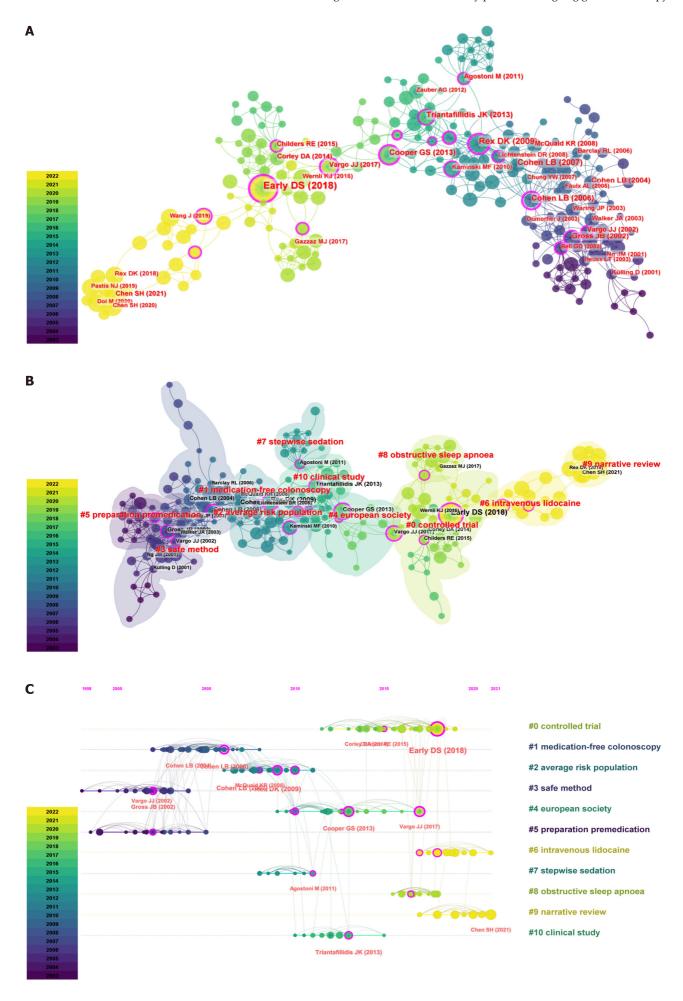
Figure 4 Analysis of co-occurrence in global research on anesthetic management for painless gastroenteroscopy in elderly individuals from 2004 to 2023. A: Mapping of keywords within the research domain; B: Distribution of keywords based on their chronological appearance; C: Identification of keywords with the highest citation bursts.

highlighting a significant focus on anesthetic sedative drugs. Furthermore, related terms were organized into six primary clusters: (1) Obstructive sleep apnea (OSA) and airway management (105 keywords, indicated by red circles); (2) Surveillance and risk factors (104 keywords, green circles); (3) Colonoscopy applications in colorectal cancer (104 keywords, blue circles); (4) Sedation and safety of propofol and midazolam (55 keywords, yellow circles); (5) Patient satisfaction and mortality (54 keywords, purple circles); and (6) Complications (51 keywords, cyan circles). Figure 4B illustrates the temporal distribution of keywords, with label colors reflecting their chronological order. In the initial decade, research primarily concentrated on anesthetic drugs and their clinical applications. Current trends indicate that airway management and associated risks are likely to emerge as important research hotspots.

Detection of keyword bursts: We identified the top 25 keyword bursts from 2004 to 2023 (Figure 4C). The timeline is depicted as a straight line featuring blue and red segments, where the red section represents the burst period. The length of this segment indicates the start year, end year, and duration of the burst. Between 2004 and 2023, "upper gastrointestinal endoscopy" (8.12) exhibited the most significant keyword burst, followed by "meperidine" (7.31), "management" (6.5), "conscious sedation" (5.69), "general anesthesia" (5.51), "pain" (5.24), and "gastroenterologist" (5.13). The analysis of keyword burst trends suggested that "adenoma detection rate" (2017-2022), "management" (2018-2022), and "obstructive sleep apnea" (2018–2020) are emerging hotspots for future investigation.

Analysis of research hotspots

Most co-cited papers: In this study, we examined the co-citation relationships among 13497 cited references found in 714 articles and created a clustering network diagram. Figure 5A displays this network, which consists of 242 nodes and 709 links. Each node represents a cited article, with its size indicating the citation frequency. Links between nodes indicated shared citations. Nodes highlighted with purple rings are especially important as they connect the developmental stages of a field. The ten most co-cited articles are detailed in Supplementary Table 6. The study by Gross et al[11] from the University of Connecticut School of Medicine, published in Anesthesiology, was the most cited, with 58 citations. It investigated the potential link between systemic opioid use and the increased incidence of fever in parturients receiving epidural analgesia during childbirth, ultimately finding no such correlation. Another highly cited study, conducted by Cohen et al[12] from the Mount Sinai School of Medicine and published in the American Journal of Gastroenterology, involved a nationwide survey on sedation and monitoring practices during gastrointestinal endoscopic procedures in the United States, garnering 57 citations [12]. Lastly, McQuaid and Laine's study from the University of California, San Francisco, published in *Gastrointestinal Endoscopy*, was a systematic review and meta-analysis comparing the efficacy, safety, and efficiency of sedation agents used in routine endoscopic procedures such as esophagogastroduodenoscopy and colonoscopy, also with 57 citations[13].







Top 25 references with the strongest citation bursts

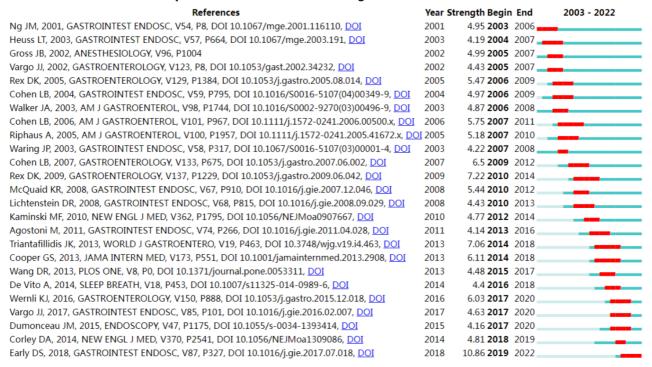


Figure 5 Analysis of research hotspots. A: Map of co-cited references; B: Cluster network diagram of co-cited references; C: Timeline visualization of co-cited clusters featuring their labels; D: The 25 references exhibiting the highest citation bursts.

Analysis of co-cited references: To identify research hotspots, we ranked articles based on their co-citation frequency within the network. The analysis revealed 11 key clusters of co-cited references: "Controlled trial", "medication-free colonoscopy", "average risk population", "safe method", "European society", "preparation premedication", "intravenous lidocaine", "stepwise sedation", "obstructive sleep apnea", "narrative review", and "clinical study" (Figure 5B). The timeline representation of the clustering plot in Figure 5C facilitates the identification of emerging research hotspots within this field.

Citation burstness denotes references that have attracted considerable attention from researchers during particular timeframes. Figure 5D displays the 25 most frequently cited articles. Among these, the highest burstness (n = 10.86) was linked to the article "Guidelines for Sedation and Anaesthesia in GI Endoscopy" by Early et al, with the citation burst spanning from 2019 to 2022. This was followed by the 2009 paper "Endoscopist-Directed Administration of Propofol: A Worldwide Safety Experience" by Rex et al. The third most significant burst was associated with "Sedation in Gastrointestinal Endoscopy: Current Issues". Notably, most of these highly cited articles appeared in journals based in the United States, particularly Gastrointestinal Endoscopy and Gastroenterology.

DISCUSSION

This study performed a bibliometric analysis of 800 original articles and reviews from the Web of Science database to explore trends and research hotspots in anesthesia management for painless gastrointestinal endoscopy in elderly patients over the last two decades. The analysis revealed a consistent annual growth in both publications and citations. Notably, in 2023, China surpassed the United States in the number of annual publications, underscoring the increasing importance of researching safer and more efficient anesthesia management methods in response to the aging global population.

Our findings revealed that the United States excels in publication volume, centrality score, and citation counts within the research network, indicating its substantial contribution and influential role in collaboration and knowledge dissemination. Among the top 10 affiliated institutions, 7 were based in the United States, potentially attributed to the country's numerous research centers and early engagement in the field. Publications from the United States tend to receive international recognition. Harvard University emerged as the leader in both the number of articles among the top 10 and its centrality score, underscoring its significant role in collaborative research. The influence of collaborative networks is evident in how they facilitate the sharing of resources, expertise, and innovative ideas, which are essential for advancing research quality. Elite institutions like Harvard University often act as hubs within these networks, fostering partnerships that lead to high-impact research outcomes. These collaborations not only enhance the visibility and citation of research but also contribute to setting global research agendas. While interactions between academic institutions worldwide have

increased, overall connection and collaboration levels remain relatively weak. To address this, there is a need for strategic initiatives that encourage more robust international partnerships. Such efforts could include joint research programs, shared funding opportunities, and international conferences that bring together diverse expertise. By strengthening these collaborative networks, the research community can drive more effective and impactful outcomes, ultimately advancing the field as a whole.

In our analysis of top journals, we found that a high impact factor is indicative of article quality. Our findings highlighted the top ten most active journals, predominantly based in the United States. Leading in publication volume were *Gastrointestinal Endoscopy*, *Digestive Diseases and Sciences*, and *Endoscopy*. These journals, classified as Q1/Q2 in the 2023 JCR, present significant potential for publishing research on anesthesia management for painless gastrointestinal endoscopy in elderly patients.

Keywords provided information about the core content of the article, and the most frequent and latest keywords can be used to identify the research trends and hotspots in specific fields during the research period[14]. A highly discussed topic in this field is OSA and the management of airway issues. According to estimates, over one billion people worldwide suffered from OSA, with its incidence increasing linearly with body weight and age[15]. OSA had significant impacts on neurofunctional disorders, vascular diseases, metabolic dysfunction, depression, and cancer[16-19]. Patients with OSA face a significant risk of experiencing adverse airway events during sedation and anesthesia[20,21]. Many presumed consequences of OSA overlapped with changes that occurred during the aging process, leading to its frequent under-recognition in the elderly[22]. Propofol, when used in combination with opioids, was the most frequently administered sedative for gastroenteroscopy; however, it poses a risk of airway obstruction and respiratory depression[23]. Consequently, implementing suitable sedation protocols and management strategies is essential to ensure ventilatory safety during painless gastroenteroscopy in elderly patients.

Sedation during endoscopy is commonly employed to reduce patients' anxiety, discomfort, pain, and the risk of vasovagal reactions. Globally, propofol and midazolam, often used in conjunction with opioids, are the most frequently utilized sedatives for gastroenteroscopy procedures[24,25]. Propofol had a relatively fast renal clearance rate and strong anti-anxiety and amnestic properties[26]. The midazolam and propofol combination exhibited a synergistic effect, significantly reducing the required propofol dosage, thereby minimizing dose-related side effects and enhancing safety in elderly patients[27]. Therefore, midazolam/propofol combination sedation emerged as a valuable option for gastrointestinal endoscopy in elderly patients, especially those with multiple comorbidities.

Eldawlatly *et al*[28] highlight the general safety of procedural sedation analgesia in elderly patients, emphasizing the need to avoid under-treatment of pain to prevent discomfort. Tailoring sedation to individual needs ensures both safety and comfort during procedures. Xu *et al*[29] support optimizing post-anesthesia care by demonstrating that intravenous infusion accelerates recovery and enhances patient comfort in elderly patients following painless colonoscopy, encouraging compliance in future procedures. These insights underscore the importance of personalized sedation strategies and post-procedure management to improve outcomes for elderly patients.

This study was intriguing as it conducted a thorough examination of existing literature and data, utilizing bibliometric analysis for the first time to investigate anesthesia management for painless gastroenteroscopy in the elderly. It identified potential future research directions with accurate and objective results. Future research should prioritize refining sedation protocols to minimize respiratory complications, especially in patients with OSA and other age-related conditions. Given the synergistic effects of midazolam and propofol, further studies are needed to optimize drug dosages and combinations specifically tailored for elderly patients with comorbidities. Basic research could also focus on developing new sedatives or adjunct therapies that reduce airway obstruction and respiratory depression while ensuring effective sedation. Additionally, the impact of sedation on long-term cognitive function in elderly patients is a crucial area of study, particularly in light of the global aging population. In conclusion, future research should aim to enhance sedation safety, optimize anesthetic protocols, and address the challenges of airway management, particularly for elderly patients with OSA and multiple comorbidities.

Limitations

Bibliometric analysis has been widely applied in clinical practice and research[30]. However, limitations existed in this study. First, we relied exclusively on the Web of Science Core Collection and did not include other databases such as PubMed and Scopus. Variations in databases could result in different publication and citation counts, potentially influencing our overall findings. Second, focusing solely on English-language articles may have limited article retrieval. Lastly, as our study was time-limited, the article count was subject to change. Rapid research updates might have overlooked certain focal points. Future research should aim to offer a more comprehensive overview and analysis to further investigate this topic.

CONCLUSION

With the population pyramid shifting towards longer lifespans, an increasing number of elderly patients have undergone gastrointestinal examinations, potentially with underlying heart or respiratory conditions and electrolyte disorders from colon preparation. Targeted clinical and observational trials are essential to offer appropriate clinical treatments for these specific elderly population.

FOOTNOTES

Author contributions: Wang G conceived and designed the study; Zhen B participated in data processing and statistical analysis; Li JJ drafted the manuscript; Jin CN, Jia J, and Liu FH contributed to data analysis and interpretation; Bai YH supervised the review of the study; all authors seriously revised and approved the final manuscript.

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CASE REPORT

Hyperbaric oxygen therapy in the treatment of severe gastric laceration with active bleeding: A case report

Jie-Li Chen, Hui-Xin Zhi, Jun-Yu Pan, Ze-Han Chen, Jia-Lan Huang, Jun Yao

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Abstract

BACKGROUND

Endoscopic therapy is the primary approach for treating Mallory-Weiss syndrome, particularly under conditions of mucosal protection and gastric acid suppression. However, for a subset of patients who cannot undergo endoscopic intervention or for whom such treatment proves ineffective, alternative measures like arterial embolization or surgical intervention may be required. While hyperbaric oxygen therapy (HBOT) has been applied across a range of medical conditions, its application in managing hemorrhage due to gastric tears remains undocumented.

CASE SUMMARY

A 52-year-old patient was admitted with symptoms of hematemesis and melena, and an endoscopy revealed a gastric fundus tear approximately 4 cm × 5 cm in size. The lesion was considered unsuitable for endoscopic repair by the attending endoscopist. Despite conservative measures, including fasting and acid suppression, the patient experienced persistent bleeding and a substantial decrease in hemoglobin levels relative to admission values. Following a multidisciplinary consultation, HBOT was initiated, resulting in the cessation of bleeding and rapid wound healing.

CONCLUSION

For patients with gastric tears presenting with active hemorrhage, HBOT might offer an effective alternative when conventional endoscopic therapies are not viable or have been unsuccessful.

Key Words: Hyperbaric oxygen therapy; Gastric laceration; Mallory-Weiss syndrome; Gastrorrhagia; Non-endoscopic hemostasis; Case report

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Core Tip: This case highlights the rapid healing of a gastric laceration using hyperbaric oxygen therapy, an approach not previously reported for treating gastric mucosal tears. Our findings suggest that hyperbaric oxygen therapy can be a viable treatment option for managing severe gastric lacerations with active bleeding, especially in cases where conservative or endoscopic therapies have failed and surgical intervention is not indicated.

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INTRODUCTION

Mallory-Weiss syndrome (MWS) is marked by tears in the lower esophagus or at the gastroesophageal junction and gastric mucosa, typically resulting from a sudden surge in intra-abdominal pressure caused by severe vomiting, intense coughing, or blunt abdominal trauma[1]. This syndrome's primary clinical manifestation is upper gastrointestinal bleeding, with epidemiological data indicating that esophageal and gastric mucosal tears contribute to 5%-15% of all cases of upper gastrointestinal bleeding[2]. Most MWS patients experience minor bleeding, and small tears often heal spontaneously within 72 hours under conservative management. However, in cases with active bleeding, endoscopy is generally the most effective and preferred treatment approach[3]. For patients unable to undergo endoscopic therapy or those for whom it has proven ineffective, options such as arterial embolization or emergency surgery are typically considered.

Hyperbaric oxygen therapy (HBOT) is widely recognized as an effective treatment for ischemic and hypoxic conditions, including decompression sickness, carbon monoxide poisoning, and gas gangrene, due to its rapid therapeutic effects. Its application has expanded to various medical conditions [4,5]. Within the gastrointestinal domain, HBOT is primarily used for managing radiation esophagitis, ulcerative colitis, Crohn's disease, and ischemic anastomotic healing [6-8]. However, there are currently no reports of HBOT being employed for hemorrhagic gastric lacerations. This case report will document the first successful use of HBOT to treat a significant gastric laceration with active bleeding, showcasing its potential as a novel therapeutic approach in such cases.

CASE PRESENTATION

Chief complaints

A 52-year-old female presented with a 1-day history of vomiting and hematemesis.

History of present illness

The patient initially experienced vomiting of gastric contents after consuming chicken soup, which was followed by the vomiting of approximately 80 mL of bright red blood and a single episode of melena. Upon admission, gastroscopy revealed a 4 cm × 5 cm laceration in the gastric fundus with active bleeding, accompanied by a hematoma at the esophagogastric junction. The laceration extended nearly through the full thickness of the muscle layer, and a substantial amount of dark red blood was present in the stomach.

History of past illness

The patient had a history of long-term aspirin and atorvastatin use for hyperlipidemia, a previous episode of gastric bleeding 3 years ago, and a history of uterine fibroid surgery.

Personal and family history

The patient's other personal and family histories were unremarkable.

Physical examination

Upon admission, the patient's vital signs were stable, with a temperature of 36.6 °C, pulse rate of 68 beats per minute, respiratory rate of 16 breaths per minute, and blood pressure of 132/84 mmHg. Abdominal examination showed a nondistended, soft, and non-tender abdomen. Mild abdominal tenderness and rebound pain emerged on the 3rd day of hospitalization but had largely resolved by the 7th day.

Laboratory examinations

Initial laboratory tests indicated a hemoglobin concentration of 110 g/L (normal range: 115-150 g/L). During the first 3 days of hospitalization, the patient experienced black, watery stools, with a daily volume ranging from 200 mL to 550 mL, resulting in a hemoglobin decrease to 83 g/L by the 3rd day.

Imaging examinations

On admission, chest and abdominal computed tomography scans revealed a small amount of air within the cervical esophagus and surrounding soft tissues, with no signs of gastric perforation in the abdominal cavity. An emergency endoscopy performed on the day of admission identified a hematoma at the esophagogastric junction and a large volume of dark red blood in the stomach (Figure 1A and B, Video 1). A tear in the gastric fundus, approximately 4 cm × 5 cm in size, was observed with blood clots, though perforation could not be definitively determined. On the 3rd day, a follow-up gastroscopy showed prolapse of the gastric fundal mucosa and muscular layer covered by a hematoma, along with congestion, edema, and erosion at the esophagus and gastroesophageal junction (Figure 1C and D). By the 11th day, repeat endoscopy indicated notable improvement in the gastric fundus, with ulcer formation and no visible hematoma in the esophagus. Multiple mucosal defects in the esophagus showed signs of improvement (Figure 1E and F). On the 16th day, further endoscopic examination demonstrated a marked reduction in the gastric fundal ulcer size and continued healing of the esophageal mucosal defects (Figure 1G and H).

MULTIDISCIPLINARY EXPERT CONSULTATION

A multidisciplinary consultation was conducted, involving specialists from thoracic surgery, gastrointestinal surgery, and the intensive care unit.

FINAL DIAGNOSIS

The final diagnosis was MWS.

TREATMENT

Due to the extensive tear and severe mucosal erosion, the endoscopist deemed endoscopic hemostasis inappropriate. The patient was initially managed conservatively with fasting, proton-pump inhibitor and hemostatic agent. Despite these measures, the patient continued to pass black, watery stools, ranging from 200 mL to 550 mL per day. Urgent follow-up endoscopy revealed worsening erosion and bleeding at the gastric fundus tear site, along with an aggravated esophageal hematoma. Given the patient's stable vital signs and the absence of esophageal or gastric perforation, the gastrointestinal and thoracic surgery teams recommended ongoing conservative treatment. On the 5th day, HBOT was initiated, involving mask oxygen inhalation at a pressure of 1.6-2.2 atmospheres absolute for 60-70 minutes per session, and was administered over nine consecutive days.

OUTCOME AND FOLLOW-UP

By the 11th day of hospitalization, the patient's stool color returned to normal. She was discharged in stable condition after a 16-day hospital stay, and no signs of bleeding were observed at the 30-day follow-up.

DISCUSSION

This case was diagnosed as MWS, notable for the extensive tear in the gastric fundus, involving a near full-thickness rupture of the muscular layer. Endoscopic treatment was considered unsuitable as sufficient inflation to visualize the wound could have worsened the tear and increased the risk of perforation. Additionally, the wound's mucosal edges were highly congested and swollen, posing a risk of further damage when using hemostatic clips, which could potentially shift and fail to achieve a secure closure. Other closure devices, such as over-the-scope clips, were also deemed ineffective due to the elongated nature of the wound. Unlike small circular defects, this type of injury could result in the detached gastric wall folding, preventing effective closure.

Given the ongoing bleeding despite conservative treatment and the lack of surgical indication, the patient proceeded with HBOT alongside proton-pump inhibitors. A follow-up endoscopy on the 7th day of HBOT revealed an almost complete absence of white coating on the ulcer surface, indicating substantial healing progress. In a study involving 70 patients who underwent endoscopic submucosal dissection, the artificial ulcers measured an average of 34.7 mm and were all in the active stage 7 days after treatment with proton pump inhibitors[9]. In contrast, the laceration wound in this case was both larger and deeper than the postoperative wound described in the aforementioned literature. However, it is noteworthy that the ulcer had entered the healing stage after a period of 7 days. Therefore, the combination of HBOT with conservative treatment proved to be more effective, this integrated approach facilitated a rapid cessation of bleeding and significantly accelerated the healing process of wounds.

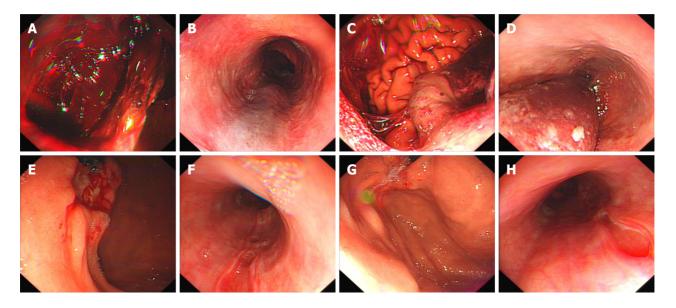


Figure 1 Endoscopic visualization of the healing process in the gastric fundus and esophagus during hospitalization. A: Endoscopic images of the gastric fundus at day 1; B: Endoscopic images of the esophagus at day 1; C: Endoscopic images of the gastric fundus at day 3; D: Endoscopic images of the esophagus at day 3; E: Endoscopic images of the gastric fundus at day 11; F: Endoscopic images of the esophagus at day 11; G: Endoscopic images of the gastric fundus at day 16; H: Endoscopic images of the esophagus at day 16.

Existing studies indicate that HBOT can enhance coagulation at wound sites by activating and recruiting platelets and upregulating tissue factor expression, thus supporting the clotting cascade[10,11]. Additionally, HBOT promotes wound healing by stimulating tissue formation, angiogenesis, and re-epithelialization[12,13]. This evidence supports the potential efficacy of HBOT in managing gastric tears with active bleeding. Nevertheless, as this report is based on a single case, further research is needed to establish its precise therapeutic value. Reviewing this patient's treatment pathway suggests that for patients with gastric lacerations, particularly those who cannot undergo endoscopic intervention yet exhibit ongoing bleeding, integrating HBOT with conventional treatments offers a promising strategy. This combined approach can notably accelerate the healing of extensive ulcerative wounds and prevent further blood loss.

CONCLUSION

HBOT presents a promising alternative for managing patients with gastric tears and active bleeding, particularly when endoscopic intervention is unfeasible or has proven ineffective.

FOOTNOTES

Author contributions: Chen JL and Zhi HX drafted the manuscript; Yao J revised the manuscript; Pan JY and Chen ZH acquired the data and figures; Huang JL managed the patient and provided the case; and all authors had access and approved the last version of the manuscript.

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CASE REPORT

Complete resection of recurrent anal canal cancer using endoscopic submucosal dissection and transanal resection: A case report

Mayuko Kinoshita, Tetsuro Maruyama, Shutaro Hike, Takuya Hirosuna, Shunsuke Kainuma, Kazuya Kinoshita, Akira Nakano, Gaku Ohira, Masaya Uesato, Hisahiro Matsubara

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Abstract

BACKGROUND

Early anal canal cancer is frequently treated with endoscopic submucosal dissection (ESD) to preserve anal function. However, if the lesion is in the anal canal, then significant difficulties such as bleeding and challenges associated with scope manipulation can arise.

CASE SUMMARY

A 70-year-old woman undergoing follow-up after transverse colon cancer surgery was diagnosed with anal canal cancer extending to the dentate line. The patient underwent a combination of ESD and transanal resection (TAR). The specimen was excised in pieces, which resulted in difficulty performing the pathological evaluation of the margins, especially on the anal side where TAR was performed and severe crushing was observed. Careful follow-up was performed, and local recurrence was observed 3 years postoperatively. Because the patient had superficial cancer without lymph node metastasis, local resection was performed again. The second treatment attempt was improved as follows: (1) TAR and ESD were performed appropriately based on the situation by the same physician; (2) A needle scalpel was used during TAR to prevent tissue crushing; and (3) The lesion borders were marked using ESD techniques before treatment. Complete resection was performed without complications.

CONCLUSION

Anal canal lesions can be safely and reliably removed when ESD and TAR are

used appropriately.

Key Words: Anal canal cancer; Recurrence; Endoscopic submucosal dissection; Transanal resection; Case report

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Core Tip: Early anal canal cancer is frequently treated with endoscopic submucosal dissection at many institutions to preserve the anal function. However, lesions located in the anal canal are more difficult to resect because of the high risk of bleeding and difficulty of endoscopic manipulation. We encountered a case of early anal canal cancer that recurred after insufficient combined endoscopic submucosal dissection and transanal resection. After improving the treatment technique, complete resection of the lesion was achieved. This report describes the precautions and areas of improvement related to our treatment method.

Citation: Kinoshita M, Maruyama T, Hike S, Hirosuna T, Kainuma S, Kinoshita K, Nakano A, Ohira G, Uesato M, Matsubara H. Complete resection of recurrent anal canal cancer using endoscopic submucosal dissection and transanal resection: A case report. World J Gastrointest Endosc 2025; 17(1): 101119

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INTRODUCTION

Early anal canal cancer and early rectal cancer that reach the upper edge of the anal canal or extend into the anal canal can present difficulties during endoscopic submucosal dissection (ESD) because of poor visualization caused by inadequate dilation of the anal sphincter. Additionally, the well-developed venous plexus in this area can lead to challenges achieving hemostasis[1]. Conversely, when anal canal cancer invades the rectum, transanal resection (TAR) alone may result in poor visibility of the proximal lesion, potentially leading to insufficient resection of the proximal margin. We report a case of anal canal carcinoma extending from the dentate line to the rectum. We performed resection of the lesion using a combination of ESD and TAR as the initial treatment. However, the specimen was severely crushed, thus leading to difficulty performing an accurate pathological evaluation. Additionally, local recurrence occurred. We investigated the problems with the initial treatment and made some improvements. As a result, the second treatment attempt resulted in complete removal of the lesion.

CASE PRESENTATION

Chief complaints

A 70-year-old woman presented without any chief complaint.

History of present illness

One year after laparoscopic right hemicolectomy was performed for transverse colon cancer (pT4aN1M0, pathologic stage IIIa), early anal canal cancer was detected during lower gastrointestinal endoscopy. Therefore, a treatment plan was designed.

History of past illness

The patient had a history of hypertension, diabetes, chronic thyroiditis, and transverse colon cancer.

Personal and family history

The patient's medical history included well-controlled hypertension.

Physical examination

A physical examination indicated that the patient had a height of 166 cm and weight of 49.5 kg.

Laboratory examinations

The carcinoembryonic antigen level was mildly elevated (7.6 ng/mL).

Imaging examinations

During lower gastrointestinal endoscopy, a 20-mm 0-IIa+Is lesion was observed on the left wall of the anal canal. A lesion extending 5 mm beyond the dentate line was observed on the anal side. The oral side extended slightly beyond the



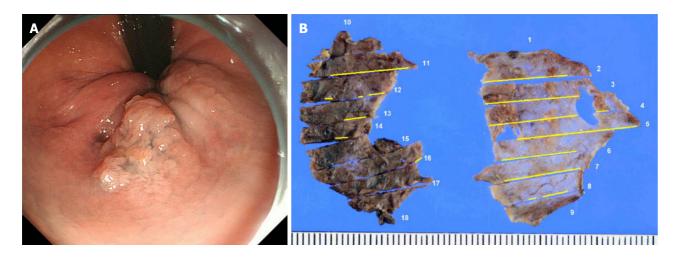


Figure 1 Endoscopic image at initial presentation. A: A 20-mm elevated lesion on the left wall of the anal canal; B: The number represents the cross section, and the tumor is identified by the yellow line. But the specimen was removed in two sections. Therefore, it was difficult to evaluate.

Hermann line into the rectum (Figure 1A). The biopsy results indicated a diagnosis of papillary adenocarcinoma (group 5). Computed tomography and magnetic resonance imaging evaluations showed no lymph node or distant metastasis.

FINAL DIAGNOSIS

The preoperative diagnosis was anal canal cancer (from lower rectum to anal canal, 0-IIa+Is, cT1aN0M0 cStageI).

TREATMENT

ESD and TAR were performed under general anesthesia with the patient in the lithotomy position. Because of the difficulty visualizing the entire tumor during transanal observation under general anesthesia, ESD was performed on the oral side and TAR was performed on the anal side as planned. A dual knife was used for ESD and a flat electric knife was used for TAR. Different surgeons performed ESD and TAR. ESD was first performed by dissecting from the oral side to near the dentate line. Then, TAR was performed. During TAR, the tumor was dissected and the tumor borders were visually checked. Although the field of view became poor and ESD was considered preferable at times during TAR, it was continued. As a result, the specimen was resected in pieces and severe crushing occurred. The surgery lasted 106 minutes, and blood loss was minimal.

During the initial treatment attempt, two different physicians performed ESD and TAR. After ESD was completed by the first physician, the second physician performed TAR. Therefore, although ESD was necessary during TAR because of the poor field of view that developed, continuation of TAR was necessary, resulting in a fragmented specimen. To achieve an improved outcome, the same physician performed both ESD and TAR appropriately during the second treatment attempt. Additionally, during the initial treatment attempt, precise control of the spatula-type scalpel on the dissection line during TAR with a large cauterization area was difficult and may have caused tumor remnants. Therefore, during the second treatment attempt, a needle-type scalpel was used during TAR to minimize tissue damage. Additionally, we marked the boundaries of the lesions, even areas that were visible to the naked eye, using an endoscopic technique.

First, the lesion borders were marked under endoscopic magnification. ESD on the oral side was performed by dissecting as much of the mucosa as possible. Second, TAR was performed. As dissection from the anal side was continued, clear observation became difficult because of severe fibrosis in the center of the lesion. Therefore, ESD was performed again from the oral side. By using the dissection layer created on the anal side as a landmark, it was possible to continue the dissection further toward the anal side. Then, we performed TAR again using the dissection layer created during ESD as a landmark. Finally, en bloc resection of the tumor was achieved without damaging the specimen or muscle layer (Figure 2). The surgery lasted 212 minutes and resulted in blood loss of 5 mL.

OUTCOME AND FOLLOW-UP

The pathological findings revealed well-differentiated tubular adenocarcinoma and tubular adenoma [from lower rectum to anal canal, type 0-IIa+IIb, 28 mm × 22 mm, tubulin beta-1 (tub1) > papillary adenocarcinoma, pTis, ly0, v0, pHM0 (1000 μm), pVM0 (100 μm)]. However, the specimen was highly damaged, and we determined that an accurate pathological evaluation would be difficult (Figure 1B). Therefore, we conducted careful follow-up that included lower gastrointestinal endoscopy at 6, 12, 24, and 36 months after surgery. Recurrence was detected during lower gastrointestinal endoscopy

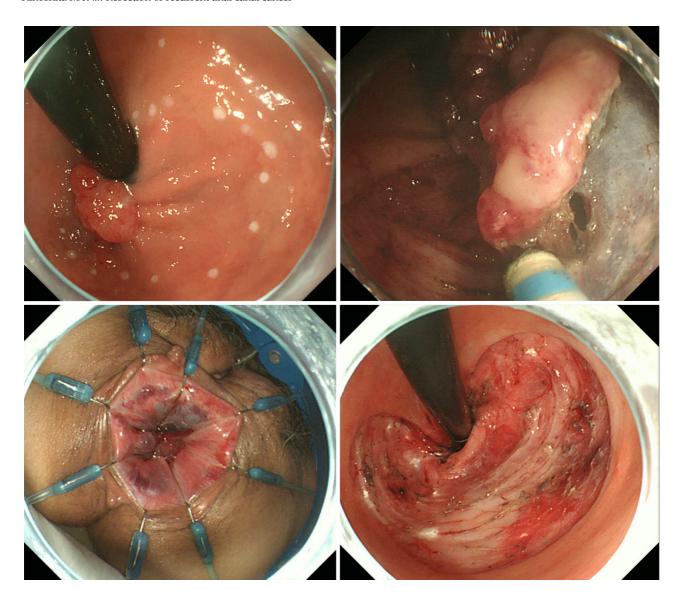


Figure 2 The entire circumference was marked, and endoscopic submucosal dissection and transanal resection were performed. The specimen was resected without damage.

performed 3 years postoperatively. Recurrence comprised a 20-mm subpedunculated lesion on the left anterior wall of the rectum. The tumor extended into the anal canal. The tumor boundaries were recognizable during narrow band imaging with magnification. However, they were difficult to detect macroscopically because of slight changes in the abnormal blood vessels on the mucosal surface (Figure 3). The biopsy results indicated a diagnosis of adenocarcinoma (tub1 > tub2, group 5). Computed tomography and magnetic resonance imaging evaluations confirmed the absence of lymph node metastasis and distant metastasis. Therefore, we decided to proceed with localized treatment. The histopathological findings of reoperation were from lower rectum to anal canal, type 0-IIa+IIc+Isp, 78 mm × 36 mm, tub1 > papillary adenocarcinoma, pTis, ly0, v0, pHM0 (1000 μm), and pVM0 (100 μm) (Figure 4). After surgery, the patient was discharged without any complications and without anal dysfunction. At 2 years and 6 months after surgery, no recurrence was observed.

DISCUSSION

In Japan, the following factors are associated with a high risk of lymph node metastasis when rectal cancer is treated endoscopically: (1) Submucosal invasion distance ≥ 1000 µm; (2) Positive vascular invasion; (3) Poorly differentiated adenocarcinoma, signet-ring cell carcinoma, or mucinous carcinoma; and (4) Budding grade 2/3 at the invasive front. Complete resection of the lesion in one piece is necessary for an accurate pathological diagnosis, and fragmented and incomplete resections result in a high local recurrence rate[2]. Anal canal cancer is defined by the Colorectal Cancer Treatment Guidelines (Japanese guidelines in 2024) as cancer arising on the anal side of the Hermann line. Anal canal cancer is relatively rare, accounting for approximately 0.7% to 1.8% of all colorectal cancers[3]. Early rectal cancer and adenoma treatment, which aims to preserve the anal function, often includes ESD at many institutions. Despite the high

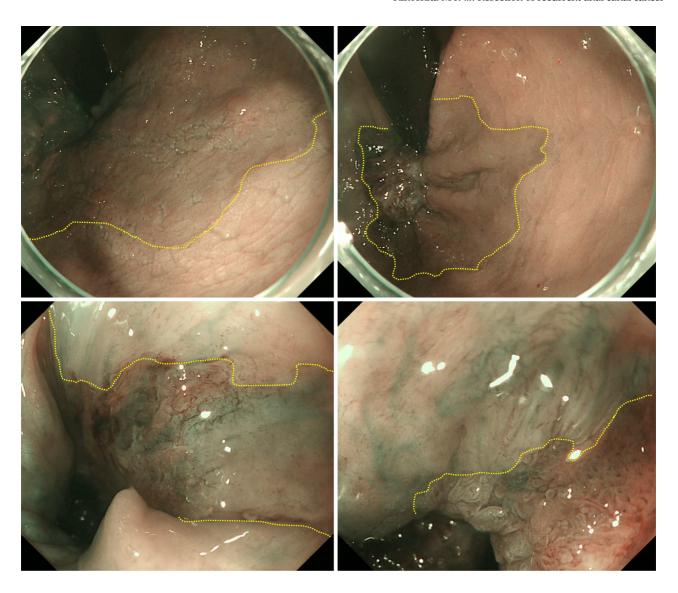


Figure 3 A 20-mm Isp lesion on the left anterior wall of the rectum. The demarcation line is observed circumferentially using narrow band imaging.

level of endoscopic skills required for ESD, recent advances in endoscopic techniques and device development have improved the safety and *en bloc* resection rates for large tumors[4].

However, lesions involving the anal canal are challenging because of the narrow lumen and poor visualization caused by the sphincter, which can lead to unstable surgery with only the tip of the scope touching the anal margin. Additionally, the anal epithelium has thick submucosal arteries and veins that pose the risk of bleeding[5]. Therefore, because of poor visualization, difficulty with maneuverability, and the tendency for easy bleeding, ESD may be unsuitable for lesions within the anal canal. However, TAR may be performed for tumors close to the anus. TAR is indicated for tumors of the lower rectum up to 5 cm from the anal margin and is optimal because it rarely causes complications such as anal dysfunction, urinary dysfunction, or sexual dysfunction[6]. However, TAR is associated with poor visibility of oral lesions and a local recurrence rate of approximately 30% [7]. Therefore, TAR may be unsuitable for lesions located more than 5 cm from the anal verge. An approach that comprises combined ESD and TAR can compensate for the shortcomings of both techniques and provide safe and reliable treatment. However, only a few case reports and no comprehensive studies have been published.

During the initial surgery, the anal side boundary was confirmed visually, but not endoscopically. Therefore, the boundary may not have been accurate. Additionally, piecemeal resection of the lesion was performed during the initial surgery. This may have occurred because ESD and TAR were performed by different surgeons, thus making it difficult to switch between the two techniques and resulting in continued dissection with an unsuitable technique. During the initial surgery, the flat knife used during TAR likely caused crushing of the tissue and tearing of the specimen, thus making it difficult to evaluate the pathological margin and creating the possibility of residual disease. Therefore, in this case, recurrence may have originated from the resection margin. During the second surgery, a single surgeon performed all procedures. This enabled seamless switching between ESD and TAR. The electric knife vaporized tissue with a highfrequency current, and the needle-type knife with a smaller contact point reduced tissue damage. During reoperation, the use of the needle-type knife during TAR prevented crushing of the tissue and allowed en bloc resection. Before treatment, the lesion borders were marked using ESD techniques.

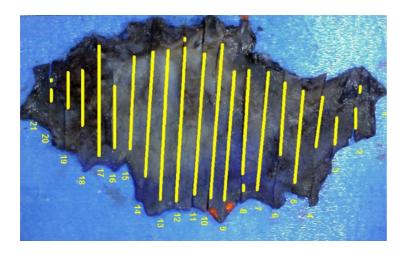


Figure 4 The number represents the cross section, and the tumor is identified by the yellow line. The specimen was removed without damage.

CONCLUSION

Understanding the advantages and disadvantages of ESD and TAR and performing them appropriately can result in safe and reliable removal of lesions in the anal canal, which are considered difficult to treat.

FOOTNOTES

Author contributions: Kinoshita M wrote this manuscript; Hike S, Hirosuna T, Kainuma S, and Kinoshita K reviewed related literature; Maruyama T, Nakano A, Ohira G, and Uesato M reviewed the manuscript; Matsubara H comprehensively supervised the manuscript.

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CASE REPORT

Multimodal artificial intelligence system for detecting a small esophageal high-grade squamous intraepithelial neoplasia: A case report

Yang Zhou, Rui-De Liu, Hui Gong, Xiang-Lei Yuan, Bing Hu, Zhi-Yin Huang

Specialty type: Gastroenterology and hepatology

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Unsolicited article; Externally peer reviewed

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade C

Novelty: Grade B

Creativity or Innovation: Grade B Scientific Significance: Grade B

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Hours



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Abstract

BACKGROUND

Recent advancements in artificial intelligence (AI) have significantly enhanced the capabilities of endoscopic-assisted diagnosis for gastrointestinal diseases. AI has shown great promise in clinical practice, particularly for diagnostic support, offering real-time insights into complex conditions such as esophageal squamous cell carcinoma.

CASE SUMMARY

In this study, we introduce a multimodal AI system that successfully identified and delineated a small and flat carcinoma during esophagogastroduodenoscopy, highlighting its potential for early detection of malignancies. The lesion was confirmed as high-grade squamous intraepithelial neoplasia, with pathology results supporting the AI system's accuracy. The multimodal AI system offers an integrated solution that provides real-time, accurate diagnostic information directly within the endoscopic device interface, allowing for single-monitor use without disrupting endoscopist's workflow.

CONCLUSION

This work underscores the transformative potential of AI to enhance endoscopic diagnosis by enabling earlier, more accurate interventions.

Key Words: Artificial intelligence; Multimodal artificial intelligence system; Esophageal squamous cell carcinoma; High-grade intraepithelial neoplasia; Case report

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Core Tip: This study introduces a novel multimodal artificial intelligence system (MAIS) based on the QueryInst network for real-time detection and delineation of esophageal squamous cell carcinoma and precancerous lesions during endoscopy. Unlike traditional artificial intelligence systems, MAIS integrates directly into the endoscopic device, allowing for singlemonitor use without altering the endoscopist's workflow. This case report demonstrates its ability to accurately identify a flat esophageal lesion, which was confirmed as high-grade squamous intraepithelial neoplasia. The findings highlight potential of MAIS for improving early diagnosis and biopsy accuracy in high-risk gastrointestinal conditions such as esophageal squamous cell carcinoma.

Citation: Zhou Y, Liu RD, Gong H, Yuan XL, Hu B, Huang ZY. Multimodal artificial intelligence system for detecting a small esophageal high-grade squamous intraepithelial neoplasia: A case report. World J Gastrointest Endosc 2025; 17(1): 101233

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DOI: https://dx.doi.org/10.4253/wjge.v17.i1.101233

INTRODUCTION

Artificial intelligence (AI) has developed rapidly in recent years in terms of endoscopic-assisted diagnosis of gastrointestinal diseases[1]. Several clinical studies have reported the auxiliary diagnostic performance of AI in clinical practice, highlighting the great potential of its application in real clinical settings. Considering the high morbidity and medical burden of esophageal squamous cell carcinoma (ESCC) worldwide, our team has successfully developed a multimodal AI system (MAIS) based on the QueryInst network, which can detect and delineate ESCC and precancerous lesions in realtime for accurate biopsy and early diagnosis[2,3]. Unlike other AI systems that required an additional monitor, MAIS was integrated directly into the endoscopic device that endoscopists used daily, i.e., single-monitor use, without changing the endoscopists' operating habits.

CASE PRESENTATION

Chief complaints

A 47-year-old man was found to have a small flat mucosal esophagus lesion during esophagogastroduodenoscopy assisted by MAIS.

History of present illness

The patient underwent esophagogastroduodenoscopy in our hospital a health examination. A small and flat mucosal lesion in the esophagus was revealed by the esophagogastroduodenoscopy.

History of past illness

The patient had no history of past illness.

Personal and family history

The patient denied any family history of malignant tumors.

Physical examination

His vital signs were as follows: Body temperature, 37.0 °C; blood pressure, 101/61 mmHg; heart rate, 68 beats per minute; respiratory rate, 15 breaths per minute. The patient also had clear breath sounds bilaterally. A soft, non-tender, abdomen, bowel sounds, and no hepatomegaly or splenomegaly.

Laboratory examinations

Laboratory examinations were absent.

Imaging examinations

During upper endoscopy, MAIS identified a flat esophageal mucosal lesion approximately 0.5 cm in diameter 31 cm from the incisors under white-light imaging, narrow band imaging (NBI), magnified NBI, and iodine staining (Figure 1A-E). The flat lesion was slightly red under white light endoscopy and brown under NBI. After magnification, the intrapapillary capillary loop was B1 type by AB classification for ESCC and lightly stained after iodine staining. MAIS not only detected and delineated the lesion but also showed the current endoscopic imaging modality with the probability value of the lesion being a cancerous lesion in the upper left of the endoscopic monitor.

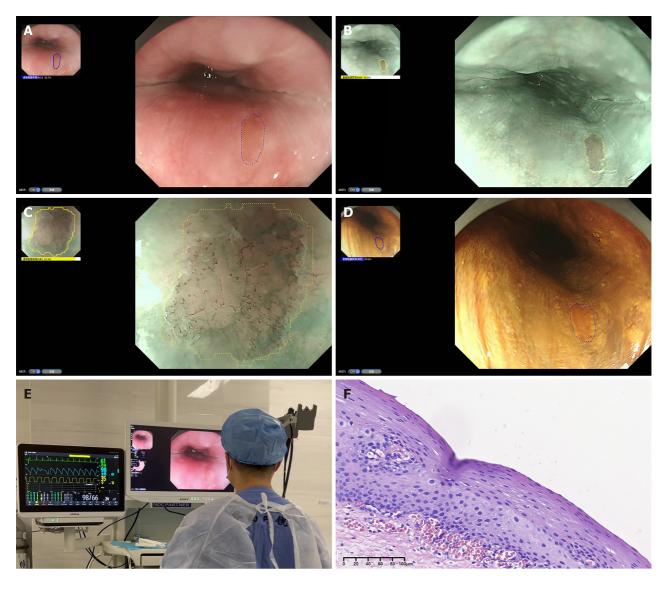


Figure 1 The multimodal artificial intelligence system identified a small and flat esophageal mucosal lesion of approximately 0.5 cm in diameter under four endoscopic imaging modalities. A: White-light imaging (blue dashed line); B: Narrow band imaging (yellow dashed line); C: Magnified narrow band imaging (yellow dashed line); D: lodine staining (blue dashed line); E: Application of the multimodal artificial intelligence system; F: Histopathology of the resected specimen showed the lesion was a high-grade squamous intraepithelial neoplasia (hematoxylin and eosin, × 200).

FINAL DIAGNOSIS

Histopathology of the specimen resected by endoscopic submucosal dissection demonstrated disordered cell polarity and nuclear atypia and enlargement, and the lesion was confirmed to be a high-grade squamous intraepithelial neoplasia measuring 3.0 mm × 2.0 mm (Figure 1F).

TREATMENT

The esophagus lesion was removed by endoscopic submucosal dissection.

OUTCOME AND FOLLOW-UP

The lesion was curatively resected, and follow-up endoscopy was planned in 6 months.

DISCUSSION

It was reported that MAIS was used to detect a small flat-type ESCC and a hypopharyngeal precancerous lesion incidentally, and showed great screening potential. We here report the smallest esophageal precancerous lesion detected by MAIS in real-time during clinical endoscopy, which was confirmed to be high-grade squamous intraepithelial neoplasia. Some large prospective studies also showed that AI improved the detection rate and miss rates of early ESCC and precancerous lesions during endoscopy. However, it is challenging to detect and delineate small flat precancerous lesions in real-time with AI, which can be missed even by senior endoscopists without AI (with experience of ≥ 10000 endoscopies)[4]. If the missed lesions developed into cancer insidiously, they would lead to heavy and economic burdens for families and society[5]. The biggest advantage of MAIS was that these four imaging modalities could meet the actual needs of hospitals different level and endoscopists to facilitate easier promotion and application of the system, especially in areas with limited medical resources. However, consistent false detection by MAIS is an unavoidable problem, which might cause anxiety among endoscopists and unnecessary biopsies. We will continue optimizing the model performance and believed that MAIS would assist endoscopists in detecting more early-stage ESCCs in the future, improving patients' prognosis.

CONCLUSION

This case highlights the significant potential of the MAIS in enhancing the detection and diagnosis of early ESCC and precancerous lesions during endoscopy. As demonstrated in this case, high-grade squamous intraepithelial neoplasia can be in real-time, and MAIS offers a reliable and integrative solution for endoscopists' daily practices. Its ability to operate seamlessly across various imaging modalities and identify tiny lesions, often challenging even for experienced clinicians, underscores its utility in advancing early cancer detection. Despite some limitations, such as false detections, the system has the advantages in terms of accessibility and adaptability, particularly for resource-constrained settings, which make it a promising tool for broader implementation. Continued optimization of MAIS could further elevate its diagnostic accuracy, ultimately reducing the clinical and economic burden of ESCC through earlier intervention and improved prognoses. This case reaffirms the transformative role of AI-driven systems in modern medical diagnostics.

FOOTNOTES

Author contributions: Zhou Y and Liu RD contributed to manuscript writing and editing; Gong H and Yuan XL contributed to multimodal artificial intelligence system training; Hu B contributed to endoscopy examination and endoscopic submucosal dissection; Huang ZY contributed to manuscript editing; and all authors thoroughly reviewed and endorsed the final manuscript.

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CASE REPORT

Cholecystogastric fistula presenting as pyloric obstruction - a **Bouveret's syndrome: A case report**

Yi Yang, Ding-Fu Zhong

Specialty type: Gastroenterology and hepatology

Provenance and peer review:

Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade C

Novelty: Grade B

Creativity or Innovation: Grade B Scientific Significance: Grade B

P-Reviewer: Tang ZX

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Hours

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Abstract

BACKGROUND

Bouveret's syndrome is a rare (1%-4%) form of cholelithiasis characterized by gastric outlet obstruction. It presents mainly in elderly women with nausea, vomiting, and abdominal pain. On physical examination, common findings include dehydration signs such as tachycardia, decreased urine output, abdominal discomfort, and distention. Diagnosis relies on computed tomography (CT) and magnetic resonance imaging, with Rigler's triad (pneumobilia, ectopic gallstone, gastric distension) being highly specific. This report aims to improve understanding of Bouveret's syndrome and inform better management and treatment strategies.

CASE SUMMARY

A 60-year-old male patient presented with a three-day history of nausea, vomiting, upper abdominal pain, and loss of appetite. An upright abdominal Xray revealed a gas shadow in the intrahepatic and extrahepatic bile ducts. Endoscopy revealed a brown and black stone measuring approximately 3030 mm in diameter in the gastric pylorus, incompletely obstructing the gastric outlet. The diagnosis of Bouveret's syndrome was accurately confirmed via an abdominal CT scan. Endoscopic removal of the stone was successful, owing to the stone being fragmented and extracted in pieces using a crushing basket. Three weeks later, laparoscopy was attempted but failed because of severe tissue adhesions. Consequently, the procedure was converted to a laparotomy, and fistula repair and cholecystectomy were performed. He returned to the outpatient clinic for followup, and no further concerns were noted.

CONCLUSION

This case highlights the importance of timely diagnosis and adaptable endoscopic and surgical approaches for effectively managing Bouveret's syndrome.

Key Words: Bouveret's syndrome; Cholecystogastric fistula; Gallstones; Endoscopic removal; Case report

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Core Tip: Bouveret's syndrome is a rare form of cholelithiasis leading to gastric outlet obstruction. Diagnosis is confirmed through imaging, particularly abdominal computed tomography, with Rigler's triad serving as a key diagnostic indicator. Endoscopic removal of the gallstone is the first-line treatment, but surgery is required if endoscopic methods fail, especially in cases with severe adhesions. In this case, a 60-year-old male had successful endoscopic stone removal. Laparotomy was later performed for fistula repair and cholecystectomy after laparoscopy failed. This case highlights the importance of early diagnosis and flexible treatment, combining endoscopy and surgery for the best outcomes.

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INTRODUCTION

Bouveret's syndrome is a rare but serious condition caused by gallstones migrating through a cholecystoenteric fistula and obstructing the gastric outlet, resulting in intestinal ileus[1]. Typically, in elderly patients with a history of cholecystitis, this syndrome presents with nausea, vomiting, abdominal pain, and loss of appetite. Prompt diagnosis and treatment are essential to prevent serious morbidity and mortality. Management often involves surgical intervention to remove the obstructing stone and concurrent antimicrobial therapy to combat any associated infection. The objective of this case report is to improve the rate of detection of an often neglected clinical condition and promote timely diagnosis and treatment for future patients.

CASE PRESENTATION

Chief complaints

A 60-year-old male patient presented with a three-day history of nausea, vomiting, upper abdominal pain, and loss of appetite.

History of present illness

The patient experienced nausea and vomiting for the past three days. He was vomiting gastric contents without blood and experienced upper abdominal pain. The patient reported no fever, chills, diarrhea, hematemesis, pruritus, or melena.

History of past illness

The patient's past medical history included diabetes.

Personal and family history

The patient's personal and family history did not indicate any factors relevant to his current illness.

Physical examination

On physical examination, the abdomen was soft, and slight tenderness was observed in the epigastric region.

Laboratory examinations

Laboratory tests revealed high levels of C-reactive protein (37.67 mg/L), a white blood cell count of 8.97 × 10⁹/L with neutrophilia (69.90%), total bilirubin level of 21.9 µmol/L, direct bilirubin levels of 4.3 µmol/L, alanine aminotransferase level of 20.8 U/L, and aspartate aminotransferase level of 23 U/L.

Imaging examinations

An upright abdominal X-ray revealed a gas shadow in the intrahepatic and extrahepatic bile ducts. Esophagogastroduodenoscopy revealed a brown and black stone measuring approximately 3030 mm in diameter in the gastric pylorus, incompletely obstructing the gastric outlet (Figure 1). An abdominal computed tomography (CT) scan revealed a circular low-density shadow measuring approximately 3028 mm in size in the antrum of the stomach, and no obvious enhancement was observed in the enhanced scan. A cystic low-density shadow in the gallbladder fossa area was observing communicating with the pyloric part of the stomach. The gastric antrum wall and gallbladder wall were



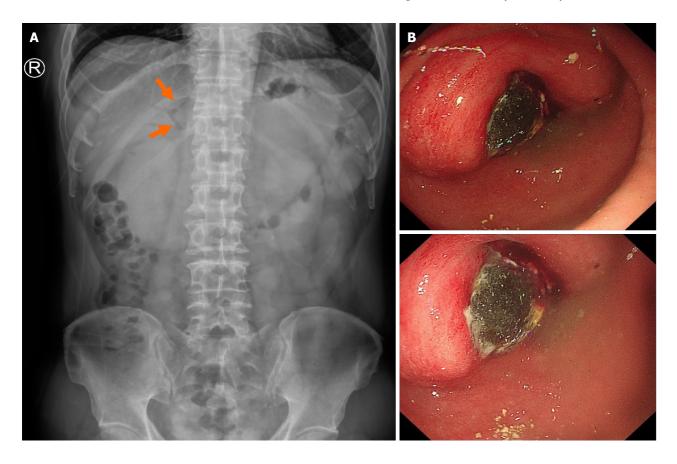


Figure 1 X-ray and Endoscopic findings. A: Abdominal X-ray image showing pneumobilia of the intrahepatic and extrahepatic bile ducts (arrows); B: Endoscopy revealing a large gallstone in the gastric pylorus leading to gastric outlet obstruction.

edematous and thickened (Figure 2).

FINAL DIAGNOSIS

On the basis of the findings described above, Bouveret's syndrome was considered a possible diagnosis.

TREATMENT

Endoscopic removal of the stone was successful. The stone was fragmented and removed piecemeal using a crushing basket. Laparoscopy was attempted three weeks later; however, severe tissue adhesions were present. The procedure was converted to a laparotomy, and fistula repair and cholecystectomy were performed. During the surgery, we encountered several challenges. First, the presence of a biliary-enteric fistula complicated the procedure, as inflammation and chronic fistulous communication had altered its anatomy. To address this, we carefully repaired the fistula, ensuring minimal disruption to surrounding structures to avoid additional complications. Additionally, the patient had significant adhesions due to chronic biliary disease, which made dissection challenging. These adhesions involved the gallbladder, bile ducts, and intestines, requiring meticulous separation to prevent injury to critical structures. In areas with severe adhesions, we employed careful dissection techniques and, when necessary, adjusted our surgical strategy to minimize trauma and ensure safe removal of the gallstone and restoration of normal anatomy.

OUTCOME AND FOLLOW-UP

The patient recovered well and was discharged on the 9th day following surgery. The patient returned to the outpatient clinic for follow-up, and no further concerns were noted.

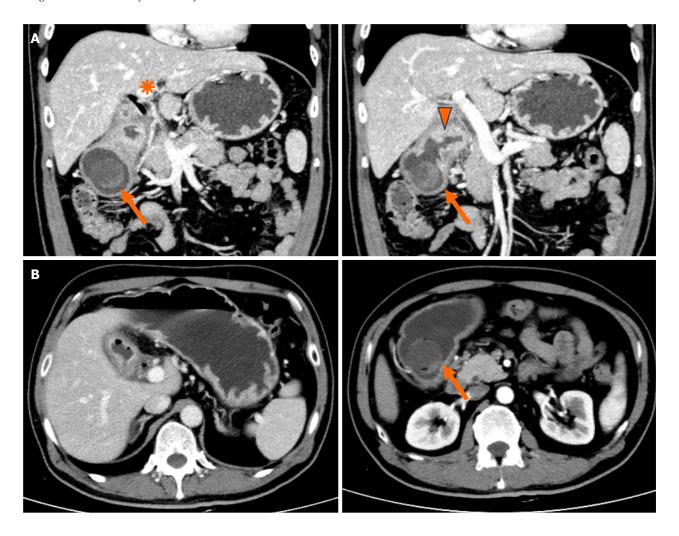


Figure 2 Computed tomography. A: Coronal computed tomography (CT) scan showing pneumobilia (asterisk) and a cholecystogastric fistula (arrowhead) with a large gallstone in the gastric antrum (arrows); B: Axial CT scan showing chronic cholecystitis with a gas-filled gallbladder and gallstones in the gastric antrum (arrow).

DISCUSSION

Bouveret's syndrome is a rare form of cholelithiasis characterized by gastric outlet obstruction due to a gallstone entering the digestive tract. Gallstones may migrate via fistulas into various parts of the gastrointestinal tract, including the ileocecal region (50%-90%), proximal jejunum and ileum (20%-40%), and the colon, stomach and duodenum (< 5%)[2]. The risk factors for Bouveret's syndrome include female sex, advanced age (> 70 years), gallstone diameter > 2.5 cm, and postoperative alterations in gastrointestinal anatomy [3,4]. Approximately 70% of patients present with nausea/vomiting (86%) and abdominal pain (70%)[4]. Imaging examinations may reveal Rigler's triad: Gastric dilation, pneumobilia, and an ectopic gallstone[4]. In the differential diagnosis of Bouveret syndrome, several conditions presenting with similar symptoms, such as upper gastrointestinal obstruction or gastrointestinal bleeding, must be considered. These include gallstone ileus, where a gallstone migrates into the intestine, typically causing small bowel obstruction rather than duodenal obstruction, which can be differentiated through imaging. Peptic ulcer disease, especially with complications like perforation or gastric outlet obstruction, shares symptoms such as epigastric pain and vomiting but can be distinguished through endoscopy and imaging. Early recognition of Bouveret's syndrome is essential, as delayed diagnosis and treatment can lead to significant complications. Given the condition's rarity and complexity, a multidisciplinary approach is recommended to ensure accurate diagnosis and optimal management, especially in elderly patients with multiple comorbidities.

Bouveret's syndrome can be treated endoscopically, surgically, or using a combination of two methods. Endoscopy can aid in both diagnosis and treatment. Generally, endoscopy and lithotripsy modalities are recommended first. Smaller stones (< 2-3 cm) can be effectively removed endoscopically with nets or baskets[1]. Larger stones are difficult to remove endoscopically, often necessitating lithotripsy techniques such as extracorporeal shockwave, electrohydraulic lithotripsy, and laser lithotripsy [5]. Endoscopic procedures are associated with complications such as intestinal wall bleeding, perforation, or distal gallstone ileus due to stone fragments. However, endoscopic visualization of the stone is possible in only approximately 69% of cases, as the stone may be embedded in the submucosa[6]. The success rate of endoscopic stone retrieval is reported to be no higher than 58% [5]. If endoscopic therapy fails or does not allow complete clearance of all stones, surgery remains the main treatment option. Common surgical procedures include enterolithotomy, fistula repair and cholecystectomy and can be performed in either one or two stages depending upon the patient's physical condition, location of the obstruction and size of the stone and fistula. Enterolithotomy, cholecystectomy, and repair of the concomitant fistula should be considered primarily for younger, healthier patients, where the risk of disease recurrence outweighs the potential perioperative risks[1]. In this case, the stone was successfully removed endoscopically. Three weeks later, fistula repair and cholecystectomy were performed. The patient experienced a smooth recovery and is in good health at the time of reporting. Follow-up care for patients with Bouveret's syndrome involves monitoring for recurrence of symptoms such as nausea, vomiting, or abdominal pain, as well as ensuring the healing of any fistulas or gastrointestinal lesions. Nutritional support is important, particularly for older patients who may have dehydration or malnutrition. Regular imaging, including CT or magnetic resonance imaging, helps detect the recurrence of gallstones or complications. Ongoing assessment ensures that the patient remains free of symptoms and maintains optimal recovery after treatment.

CONCLUSION

Bouveret's syndrome is a rare condition characterized by gastric outlet obstruction with a high mortality rate. Timely diagnosis and a personalized treatment are essential for the successful management of this disease.

ACKNOWLEDGEMENTS

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FOOTNOTES

Author contributions: Yang Y helped write and edit the manuscript and collect data; Zhong DF helped write the paper; all the authors have read and approved the content of the manuscript.

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CASE REPORT

Novel approach to managing two enormous bezoars with successive snare-tip electrocautery: A case report

Cherng Harng Lim, Cherng Jyr Lim, Chih-Ta Yao, Chi-Chun Chang

Specialty type: Gastroenterology and hepatology

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Unsolicited article; Externally peer reviewed.

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Peer-review report's classification Scientific Quality: Grade B, Grade D

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Scientific Significance: Grade B,

Grade B

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Abstract

BACKGROUND

Gastric bezoars are indigestible masses that can lead to gastrointestinal obstruction and ulceration. Standard treatments include endoscopic mechanical lithotripsy with a polypectomy snare and Coca-Cola dissolution therapy or a combination of both approaches. However, giant bezoars frequently require multiple treatment sessions and extended hospital stays. Additionally, snarebased mechanical fragmentation may be limited by factors such as bezoar size, shape, density, slipperiness, and restricted working space. In cases where refractory giant bezoars are unresponsive to traditional methods, surgical intervention is often necessary.

CASE SUMMARY

A 57-year-old male with a history of type 2 diabetes presented with severe epigastric pain and vomiting. Endoscopy revealed two large phytobezoars and a gastric ulcer. Initial attempts at mechanical fragmentation with a polypectomy snare and Coca-Cola ingestion for dissolution were unsuccessful due to the large size and complex structure of the bezoars. An innovative approach using snaretip electrocautery was then employed. It successfully penetrated the slippery, hard surface of the bezoars and fragmented them into smaller pieces. The patient was subsequently treated with Coca-Cola ingestion, enzyme supplements, and proton pump inhibitors. He was discharged without complications following the endoscopic sessions.

CONCLUSION

Snare-tip electrocautery is a safe, cost-effective, and minimally invasive alternative for managing large, refractory gastric bezoars. This is a valuable option in resource-limited settings.

Key Words: Bezoars; Electrocautery; Phytobezoars; Endoscopic removal; Snare-tip; Case report

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Core Tip: Snare-tip electrocautery provided precise and efficient fragmentation of refractory bezoars, which reduced the need for surgery. Snare-tip electrocautery may be particularly useful in cases unresponsive to conventional treatments.

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INTRODUCTION

Bezoars are foreign bodies formed within the gastrointestinal tract due to the aggregation of undigested material. They are categorized into four distinct types based on their composition: Phytobezoars; trichobezoars; pharmacobezoars; and lactobezoars[1]. Phytobezoars are prevalent in the stomach. Bezoars exceeding 3 cm in size pose an elevated risk of gastric ulcers and intestinal obstruction. Ulcers are often localized to the angulus of the stomach due to friction from the bezoar. Bezoars are treated with endoscopic mechanical fragmentation and the use of carbonated beverages such as Coca-Cola. Large bezoars typically require combination therapy consisting of multiple treatments over an extended period. The outcomes can be unsatisfactory, especially in cases of symptomatic gigantic bezoars, which often require surgical intervention. Herein, we present the case of two massive stomach bezoars complicated by symptoms of gastric outlet obstruction that were successfully managed using unconventional snare tip electrocautery.

CASE PRESENTATION

Chief complaints

A 57-year-old Asian male presented to our emergency department with severe epigastric pain.

History of present illness

The patient had a medical history of type 2 diabetes. He reported experiencing postprandial epigastric discomfort persisting for over 3 months. Recently, the patient had also began experiencing episodes of postprandial vomiting, even with the ingestion of water.

History of past illness

The patient's past medical history is unremarkable, with no significant illnesses, hospitalizations, or surgical procedures reported.

Personal and family history

Family history of Hypertension in his father.

Physical examination

Physical examination revealed abdominal distension with tenderness localized to the epigastric region.

Laboratory examinations

Laboratory analysis indicated the presence of microcytic anemia, as evidenced by hemoglobin at 9.4 g/dL (normal range: 13-18 g/dL) and mean corpuscular volume of 72.7 fl (normal range: 85.6-102.5 fl).

Imaging examinations

Kidney, ureter, bladder X-ray revealed gastric distension with fecal-like material present. Esophagogastroduodenoscopy revealed the presence of two large phytobezoars, each measuring 8 cm in diameter. They were situated within the fundus and body of the stomach. A sizable deep ulcer (Forrest IIb, 5-6 cm) located in the angular incisure extending into the antrum area was also detected (Figure 1A and B).

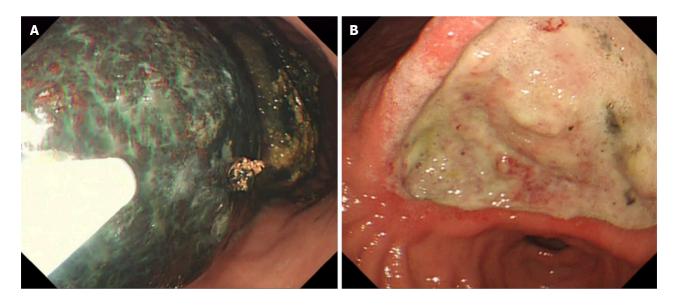


Figure 1 Esophagogastroduodenoscopy. A: Two large phytobezoars, each 8 cm in diameter, were located in the fundus and body of the stomach; B: A Forrest IIb ulcer (5-6 cm in size) was located at the angular incisure and extended into the antrum area.

FINAL DIAGNOSIS

Phytobezoar and ulcer.

TREATMENT

Initial attempts at mechanical lithotripsy utilizing a 33-mm round snare (extra-large rounded, single-use polypectomy snare; Boston Scientific, Marlborough, MA, United States) and raptor forceps were unsuccessful due to the slippery structural density of the bezoar, which prevented effective anchoring of the snare. Subsequent interventions employed the snare tip for electrocautery [forced coagulation mode, effect 2, 35-50 W (VIO 300D; Erbe, Marietta, GA, United States)] extended by approximately 2-4 mm to enable precise bezoar fragmentation while minimizing mucosal contact (Figure 2). The bezoar was reduced to fragments smaller than 2 cm to mitigate the risk of small intestine obstruction (Video).

During hospitalization, the patient's intake consisted solely of diet Coca-Cola (600-1000 mL every 6 hours) and a digestive enzyme supplement. Proton pump inhibitor therapy was initiated to address ulceration. Eight days after the initial treatment, a follow-up esophagogastroduodenoscopy demonstrated incomplete dissolution of the bezoar. There was evidence of the original unfragmented mass and the aggregation of fragmented remnants into a smaller concretion.

OUTCOME AND FOLLOW-UP

Subsequent endoscopic sessions addressed the remaining unfragmented bezoar. The day following the final endoscopic fragmentation, the patient was discharged uneventfully.

DISCUSSION

Coca-Cola is the primary treatment for the dissolution of gastric bezoars[2]. Alternatively, combined endoscopic mechanical fragmentation using lithotripters, snares, or forceps may be employed. Giant bezoars refractory to conventional treatments often require surgical intervention. Argon plasma coagulation (APC) and electrohydraulic lithotripsy have also been used to manage massive bezoars. However, only limited case series data and specific procedural reports are available[3,4].

During APC or laser lithotripsy treatment, accurately assessing the depth of fragmentation can be challenging, and the soft nature of the APC probe complicates effective manipulation of the bezoar. Similarly, electrohydraulic lithotripsy introduces a significant amount of water into the gastric lumen, which can obscure the visualization of the bezoar and surrounding mucosa, increasing the risk of gastric mucosal injury. Moreover, these methods often require additional tools, such as snares or forceps, to fragment debris effectively. Both techniques not only fail to fragment bezoars independently and are time-consuming but also pose an increased risk of mucosal injury due to limited visualization of treatment depth.

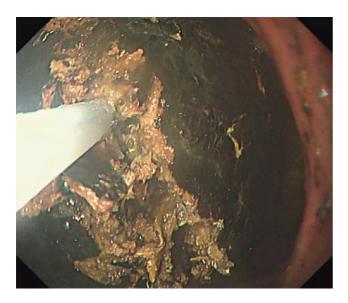


Figure 2 Snare-tip electrocautery successfully fragmented the bezoar.

In this case, snare-tip electrocautery offers a viable alternative for managing intractable bezoars, particularly in resource-limited settings where advanced equipment may not be available. Extending the snare tip approximately 0.2-0.4 cm beyond the snare sheath, similar to techniques used with a longer needle knife, allows for precise visualization of the cutting depth and helps prevent mucosal injury. Additionally, the snare sheath facilitates repositioning of the bezoar in challenging angles, enhancing procedural effectiveness. The electrocautery function reduces the stickiness of clay-like bezoars, which can otherwise impede fragmentation, enabling more efficient treatment. The same snare can also be used to fragment residual bezoar debris effectively.

CONCLUSION

Snare-tip electrocautery is an effective, safe, and cost-efficient non-surgical intervention for large, refractory bezoars. Its versatility enables precise depth control in confined spaces, and the procedure time is reduced. Snare-tip electrocautery is a valuable endoscopic option for managing refractory bezoars.

FOOTNOTES

Author contributions: Lim CH contributed to the medical care and treatment planning; Lim CJ wrote the manuscript and collected the data; Yao CT and Chang CC performed the research and provided critical suggestion. All authors reviewed and approved the final version of the manuscript. The equal contributions of Lim CH and Lim CJ were critical for the generation and production of this case report, and their collective efforts merit the co-first authorship designation.

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CASE REPORT

Early esophageal cancer with mucosal bridging in the resting room: A case report

Ying-Ling Liu, Jie Liu, Ye-Tao Wang

Specialty type: Gastroenterology and hepatology

Provenance and peer review:

Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's classification

Scientific Quality: Grade B

Novelty: Grade B

Creativity or Innovation: Grade B Scientific Significance: Grade B

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Abstract

BACKGROUND

Patients diagnosed with esophageal mucosal bridges often experience symptoms such as chest pain and dysphagia, which pose considerable challenges for endoscopic surgical interventions.

CASE SUMMARY

We present a case involving early-stage esophageal cancer discovered in a resting room, notable for the rare manifestation of esophageal mucosal bridging. Following a comprehensive multidisciplinary discussion and the development of a treatment strategy, we proceeded with endoscopic submucosal dissection for the patient. During the procedure, we encountered operational challenges due to the presence of a diverticulum and a partial absence of the muscularis propria. To facilitate the retraction of a portion of the resected specimen, we utilized dental floss. Ultimately, we successfully excised the entire lesion. After a three-day period of fasting with a water-only diet, subsequent iodine water cholangiography did not indicate any perforations, and the patient was advised to transition to a liquid diet. The patient was discharged five days post-operation. A follow-up endoscopy conducted three months later revealed scar-like changes in the mid-esophagus, with the patient reporting no significant discomfort.

CONCLUSION

In summary, although esophageal mucosal bridges are rarely documented, they should be considered in the differential diagnosis of mechanical dysphagia. Furthermore, endoscopic therapy represents a feasible approach for their management.

Key Words: Esophageal cancer; Endoscopic submucosal dissection; Esophageal mucosal bridging; Esophagus; Case report

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Core Tip: Currently, there exists a paucity of documented cases of submucosal bridges in the esophagus, and no instances have been reported linking submucosal bridges to carcinogenesis within diverticula. In the case under discussion, the tubular structure of the submucosal bridge, along with the detailed pathological features indicative of carcinogenesis, was clarified through the application of thin sectioning of the surgical specimen obtained after endoscopic submucosal dissection.

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INTRODUCTION

Esophageal mucosal bridges (EMBs) are anatomical structures that traverse the lumen of the esophagus. EMBs are considered a rare phenomenon, typically arising as a consequence of various factors including trauma from nasogastric tubes, inflammatory conditions such as Crohn's disease and lupus, infections like human immunodeficiency virus, herpes simplex virus, esophageal candidiasis, and tuberculosis, as well as complications from radiation therapy and sclerotherapy for esophageal varices[1]. Patients with EMBs may exhibit no symptoms or may present with clinical manifestations such as chest pain and dysphagia. In a recent case report, the authors highlighted endoscopic management of EMB and demonstrated that EMB management using a scissor-type knife was safe and provided durable clinical improvement [2]. In this report, we describe a case involving a 57-year-old male patient diagnosed with early esophageal cancer during a routine examination, which was notably associated with the uncommon presentation of esophageal mucosal bridging. Endoscopic submucosal dissection (ESD) was performed as part of the treatment approach.

CASE PRESENTATION

Chief complaints

The patient is a 57-year-old male who presented with a history of dysphagia and was referred to our hospital for further management after an upper endoscopy at an outside hospital revealed a high-grade intramucosal neoplasm of the esophagus.

History of present illness

The patient presented to an outside hospital with upper abdominal discomfort after an upper endoscopy revealed a patchy erythema in the mid-esophagus. Pathology suggested a high-grade intramucosal neoplasm.

History of past illness

Upon questioning the patient's history, he reported no difficulty swallowing or chest discomfort, and denied a history of trauma, foreign body impaction, or radiation therapy. He also denied a history of smoking or drinking.

Personal and family history

The patient denied any family history of malignant tumors.

Physical examination

No significant findings were noted on physical examination.

Laboratory examinations

An upper endoscopy revealed a 2.5 cm submucosal cystic lesion at the distal esophagus near the posterior wall (Figure 1A), with a 2.0 cm × 2.0 cm patchy erythema in the central area and a 1.0 cm × 0.2 cm bridging mucosal change (Figure 1B).

Imaging examinations

Narrow band imaging showed a tea-colored lesion (Figure 1B). After admission, we conducted preoperative examinations. Under magnifying endoscopy with narrow band imaging, we observed intrapapillary capillary loops in the epithelial tufts of the esophagus, which were classified as type B1 (Figure 1C). Ultrasonographic endoscopy suggested an



Figure 1 Gastroscopy appearance of lesion. A: Patchy crythema with bridge like protrusions in the esophageal diverticulum under white light; B: The lesion under narrow band imaging appears tea brown in color; C: Intrapapillary capillary loops under magnifying endoscopy with narrow band imaging shows B1 type; D: Endoscopic submucosal dissection postoperative wound; E: Lodine staining after lesion dissection; F: Scar like changes observed during 3-month postoperative follow-up.

intact mucosal layer, but a thinner muscularis propria. Chest computed tomography did not suggest any lesions or enlarged lymph nodes.

MULTIDISCIPLINARY EXPERT CONSULTATION

After a multidisciplinary discussion and formulation of a treatment plan, we performed ESD for the patient.

FINAL DIAGNOSIS

In conjunction with the patient's medical history, a pre-operative diagnosis of early esophageal cancer characterized by mucosal bridging was established in the recovery room.

TREATMENT

After a multidisciplinary discussion and formulation of a treatment plan, we performed ESD for the patient. During the procedure, due to operational difficulties within the diverticulum and partial absence of the muscularis propria, we assisted with dental floss to pull back part of the resected specimen (Figure 1D and E). We then successfully removed the entire lesion (Figure 1D and E). After a 3-day fasting and water-only diet, follow-up iodine water cholangiography did not reveal any perforations, and we instructed the patient to consume a liquid diet. The patient was discharged 5 days after the operation. While processing the specimen, we noticed that the submucosal bridge was a solid tubular structure spanning the esophageal mucosa (Figure 2A and B). Histological sections showed that the tubular structure had a circumferential epithelial lining consisting of stratified squamous epithelium, which was found both in the submucosal bridge and in the underlying esophageal mucosa. Both regions showed high-grade intramucosal neoplasia, with some areas showing in situ carcinoma changes. The tubular structure was composed of a central vascular axis surrounded by a continuous and contiguous epithelial layer, resembling a fibroepithelial polyp (Figure 2C, D and E).

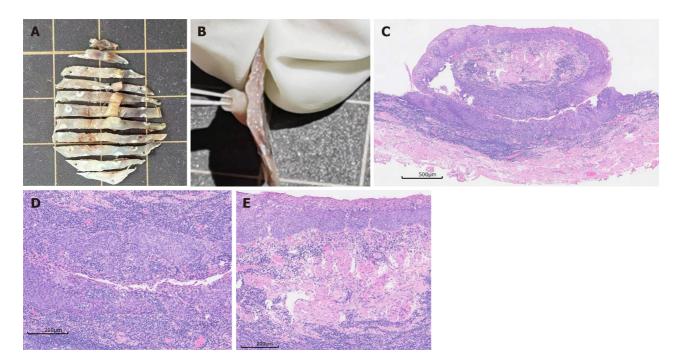


Figure 2 Pathological biopsy after specimen fixation. A: Sample after tissue incision, the red dashed line represents the front of the 2B tissue strip; B: On the side of the tissue strip, the raised mucosal bridge is a solid tubular structure; C: Pathological hematoxylin and eosin (HE) staining presented the mucosal bridge spanning the intrinsic mucosa of the esophagus, × 40; D: Pathological HE staining presented the tubular structure and esophageal mucosa, showing high-grade intraepithelial neoplasia and in situ cancer of squamous epithelium, × 100; E: Pathological HE staining presented the tubular structure. The axis of the tubular structure is composed of proliferating arteriovenous vessels and fibrous smooth muscle tissue, × 100.

OUTCOME AND FOLLOW-UP

Three months later, follow-up endoscopy showed scar-like changes in the mid-esophagus (Figure 1F), with no specific discomfort (Figure 1F).

DISCUSSION

Currently, there are fewer reported cases of submucosal bridges in the esophagus, and no reports of submucosal bridges with carcinogenesis occurring within diverticula. In this case, the submucosal bridge's tubular structure and the pathological complete presentation of carcinogenesis were shown using the advantage of thin section cutting of the surgical specimen after ESD. Submucosal bridges are linear extensions of smooth muscle tissue, which are generally seen in the intestines, especially in ulcerative colitis. There are a few reports showing that submucosal bridges can occur in the esophagus, gastric antrum, and small intestine. Studies have shown that submucosal bridges in the esophagus are tubular band-like structures that connect the esophageal wall at both ends and have a gap below, appearing as "double-lumen" or "pseudomass" on endoscopy [3]. There are two theoretical hypotheses. One is that the inflamed esophageal wall comes into contact with each other, and the connective tissue below each wall forms a bridge by adhesion, thus forming a submucosal bridge. The second is that multiple esophageal ulcers heal with submucosal communication or the formation of granuloma at the front or back of the esophagus after healing. The cause of the carcinogenic lesion in this case is unclear, and it may be related to repeated inflammatory stimulation and temporary food retention in the diverticula. Buchman reported the first case of submucosal bridges in the esophagus caused by the placement of a nasoenteric tube in 1992[4]. Salamun et al[5] reported a case of a patient with a long-term history of smoking and chronic obstructive pulmonary disease who presented with dysphagia, and endoscopy revealed a submucosal bridge in the esophagus. Histopathological examination of the esophageal biopsy showed squamous metaplasia, characterized by well-developed granular cell layer, localized epithelial dysplasia, and mild lymphocytic infiltration.

Endoscopic treatment can also be used to resolve obstructive symptoms in some symptomatic mucosal bridges, some of which are of unknown origin[6], some of which are stimulated by placement of prostheses, such as the placement of articulatory prostheses after laryngeal cancer[2], and the stimulation of mucosal bridging after esophageal fistula. In this patient, the cystoid protrusion of the middle esophageal diverticulum is not very severe, there is no obvious choking, retrosternal pain with acid reflux symptoms, and some endoscopically found diverticula is large, and active intervention and treatment are required for symptomatic ones. At present, diverticular per oral endoscopic myotomy has been widely used to perform complete diverticulectomy under direct endoscopic vision[7]. In this case, esophageal carcinoma in situ in diverticulum is an absolute indication for ESD, and endoscopic resection can be curative treatment, and regular followup is sufficient. The occurrence of mucosal bridges is considered to be a bridge-like structure across the mucosal surface formed by the axis of residual epithelium and fibrovascular vessels during the repair of inflammatory lesions.

Recent years have witnessed considerable advancements in the treatment modalities for esophageal disorders. Endoscopic intervention has emerged as the predominant therapeutic strategy for this patient demographic. Argon plasma coagulation has been shown to be both safe and effective across various clinical contexts[8]. Furthermore, electrosurgical techniques, including the utilization of hot biopsy forceps and needle knives, have been successfully employed following the placement of hemoclips at both extremities of the esophageal bridge in numerous instances[9, 10]. Presently, there is a paucity of data that directly compares the safety and efficacy of these techniques.

CONCLUSION

In summary, although EMBs are rarely documented, they should be considered in the differential diagnosis of mechanical dysphagia, and endoscopic therapy represents a feasible option for their management.

FOOTNOTES

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LETTER TO THE EDITOR

Efficacy of spray flushing in the reprocessing of flexible endoscopes

Harendra Kumar, Arkadeep Dhali, Rick Maity, Jyotirmoy Biswas

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Abstract

This article comments on the article by Du *et al*, who conducted a randomized controlled trial aiming at evaluating the effectiveness of a novel spray flushing system in cleaning flexible endoscopes while minimizing damage to the working channels. We share our perspective on the importance of improving endoscope reprocessing methods. The findings highlight the spray flushing system's capacity to improve cleaning efficacy while minimizing damage, suggesting that it might be important in enhancing endoscope reprocessing procedures.

Key Words: Spray flushing; Endoscope; Flexible endoscope; Endoscope; Endoscope cleaning; Endoscope reprocessing

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Core Tip: We comment on a randomized controlled trial by Du et al, which evaluates the efficacy of a novel spray flushing system in the reprocessing of flexible endoscopes, demonstrating its potential to reduce damage to the working channels while maintaining cleaning quality. This editorial discusses the implications of these findings for endoscopic safety, the challenges involved with traditional cleaning approaches, and the potential cost benefits of employing spray flushing devices. Furthermore, we evaluate prospective future research fields and assess the broader impact of these developments on endoscope cleaning processes and patient well-being.

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TO THE EDITOR

Endoscopic therapies are foundational approaches in modern gastroenterology, enabling precise, minimally invasive diagnosis and treatment for a wide range of gastrointestinal illnesses[1]. The success and safety of these procedures depend on thorough endoscope reprocessing to remove infection and prepare them for reuse. Historically, bristle brushes have been the preferred device for cleaning endoscopic working channels[2]. While effective, these brushes have certain drawbacks: They often cause scratches within the channels, which may serve as breeding grounds for germs and biofilms, endangering patient safety and endoscope longevity[3].

In their innovative study, Du et al[3] address this critical issue by developing a new spray flushing approach for reprocessing flexible endoscopes. Their randomized controlled research provides persuasive evidence that this unique technique not only matches the cleaning efficacy of traditional brushes but also significantly reduces mechanical damage to the endoscope's operational channels. This development holds promise not just for better cleaning outcomes but also for increasing endoscopic safety, lowering reprocessing costs, and extending the life of these critical instruments[3].

In this article, we look at Du et al's findings and place them within a larger framework of current difficulties in endoscope reprocessing[3]. We investigate the spray flushing system's potential to change present practices, the cost consequences of using such technology, and the critical need for ongoing research to improve endoscope reprocessing. By studying these obstacles, we want to demonstrate the greater impact that improved reprocessing may have on patient outcomes and overall treatment quality in gastroenterology.

Spray flushing in flexible endoscope reprocessing

We read with great interest an article entitled "Efficacy of spray flushing in the reprocessing of flexible endoscopes: A randomized controlled trial" by Du et al[3]. Reprocessing flexible endoscopes is an essential part of infection control in gastrointestinal surgeries. Traditional cleaning methods, particularly the use of bristle brushes, have long been the standard[4]. However, these brushes have been linked to issues such as channel deterioration and biofilm formation, which may jeopardize patient safety and the endoscopic equipment's lifespan[4,5]. The study by Du et al[3] presents a novel approach to addressing these difficulties by developing a spray flushing system.

Study findings and their significance

Du et al's study provides strong evidence that the spray flushing approach is more effective than ordinary cleaning brushes[3]. The randomized controlled trial included 60 endoscopes and Teflon tubes that were divided into control and experimental groups. The spray flushing method significantly reduced debris in working channels (46.7% vs 73.3% in the control group; P < 0.05) and produced less damage to Teflon tubes (median damage score of 4 in the experimental group vs. 4-5.25 in the control group; P < 0.01)[3].

These findings are significant because they show that the spray flushing approach may improve the cleaning performance of flexible endoscopes while minimizing damage to their operating channels [4,6]. This twofold benefit may result in longer-lasting endoscopes and a decreased risk of infection transmission, thereby improving patient safety and reducing healthcare costs[4].

The study also shows that the spray flushing technique is cost-effective[4]. Traditional bristle brushes, especially when used in accordance with guidelines that promote single-use to reduce cross-contamination, significantly increase reprocessing costs [6,7]. In contrast, the spray flushing system, which eliminates the need for bristle replacement, offers a more environmentally friendly and cost-effective option[4].

Potential improvements and further research

While the study of Du et al[3] shows a significant improvement in endoscope reprocessing, there are several areas where the spray flushing approach should be improved further. For example, the study found no significant difference in ATP levels between the control and experimental groups (32.5 relative light units vs 26 relative light units; P > 0.05), suggesting that, although the spray system is effective, it may not yet outperform traditional brushes in all areas of cleaning[4]. A real-world study found that even after automated endoscope reprocessor alcohol flush and air purge cycles and 10-minute forced-air drying cycles, fluid retention was still detected in endoscope channels, suggesting room for

Table 1 Comparison of spray flushing system and traditional bristle brushes in flexible endoscope reprocessing			
Parameter	Spray flushing system	Traditional bristle brushes	P value
Number of endoscopes	30	30	NA
Reduction in debris	46.7%	73.3%	<i>P</i> < 0.05
Channel damage (median score)	4	4-5.25	<i>P</i> < 0.01
ATP levels (relative light units)	26	32.5	<i>P</i> > 0.05
Compatibility with Teflon tubes	Less damage observed	More damage observed	<i>P</i> < 0.01
Cleaning efficacy	Effective, with room for improvement	Effective, standard method	NA
Long-term durability	Potentially longer-lasting channels	Standard durability	Further research needed

NA: Not available.

improvement in drying effectiveness[5]. A study by Benowitz et al[6] showed that flushing alone is inadequate to remove organisms attached to the interior of endoscopes, emphasizing the need for more effective cleaning methods that could be integrated with spray flushing technology. Moreover, a study on foam spray as an alternative for delayed reprocessing showed that foam spray could serve as a useful interim measure, suggesting that combining spraying flushing with foam applications may enhance overall reprocessing effectiveness[7]. Additionally, the Centers for Disease Control has recommended improving facility-level training and competency for reprocessing flexible endoscopes, which could be crucial in ensuring that new technologies like spray flushing are used effectively[6].

Further improvements to the spray system to increase its cleaning power may be proposed. Furthermore, the study's sample size was rather small, with 30 endoscopes in each group. Larger studies are necessary to confirm these findings over a wider range of endoscope models and clinical situations. It would also be beneficial to assess the long-term effect of using spray cleaning technology on endoscope durability and maintenance costs.

However, like with any new technology, transitioning to a spray flushing system requires careful consideration. Healthcare organizations will need to balance the initial costs of implementing this system against the long-term benefits. Furthermore, training and improvements in reprocessing processes will be required to ensure optimal use of the new technology.

Clinical implications and future directions

In practical practice, the spray flushing approach may affect endoscope reprocessing schedules. This technique may reduce the frequency of endoscope repairs and replacements by decreasing the risk of channel deterioration and biofilm formation, resulting in cost savings[4,7]. Furthermore, its ability to remove debris effectively without jeopardizing microbiological safety demonstrates its potential as a superior alternative to typical cleaning brushes[8].

To maximize the impact of this finding, additional research into its use in a variety of therapeutic settings is required. This includes evaluating its effectiveness in high-volume endoscopic facilities and ensuring compatibility with different types of endoscopes and cleaning agents. In flexible endoscope reprocessing, Table 1 compares the spray flushing approach to regular bristle brushes.

CONCLUSION

The study by Du et al[3] is a good step forward in the effort to improve endoscope reprocessing. The spray flushing system they developed offers a viable solution to some of the core problems associated with traditional cleaning methods. With further research and development, this technology has the potential to set a new standard for endoscope cleaning, resulting in safer treatments and improved outcomes for patients worldwide.

FOOTNOTES

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