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Moving scope technique improves technical success rate of device insertion during EUS-guided hepaticogastrostomy (with video)

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Kimi Bessho, Takeshi Ogura, Saori Ueno, Atsushi Okuda, Nobu Nishioka, Jun Sakamoto, Yoshitaro Yamamoto, Yuki Uba, Mitsuki Tomita, Nobuhiro Hattori, Junichi Nakamura and Hiroki Nishikawa

Abstract

Background: Technical tips for device insertion during endoscopic ultrasound-guided hepaticogastrostomy (EUS-HGS) have not been reported. To improve the technical success rate of device insertion without unnecessary tract dilation, the pushing force should be transmitted directly from the channel of the echoendoscope to the intrahepatic bile duct.

Objectives: We developed a novel technique, termed the 'moving scope technique', the feasibility of which during EUS-HGS is described.

Design: Retrospective study.

Methods: The primary outcome of this study was the technical success rate of dilation device insertion without electrocautery dilation after the moving scope technique. The initial technical success rate of dilation device insertion was defined as successful insertion into the biliary tract. If dilation device insertion failed, the moving scope technique was attempted.

Results: A total of 143 patients were enrolled in this study. The initial technical success rate for device insertion was 80.4% (115/143). The moving scope technique was therefore attempted in 28 patients. The mean angle between the intrahepatic bile duct and the guidewire was improved to 141.0° and resulted in a technical success rate of 100% (28/28). The area under the ROC curve (AUC) was 0.88, and 120° predicted successful dilation device insertion with sensitivity of 88.0% and specificity of 78.8%. Bile peritonitis ($n = 8$) and cholangitis ($n = 2$) were observed as adverse events, but were not severe.

Conclusion: In conclusion, the moving scope technique may be helpful during EUS-HGS to achieve successful insertion of the dilation device into the biliary tract. These results should be evaluated in a prospective randomized controlled trial.

Keywords: endoscopic ultrasound-guided biliary drainage, ERCP, biliary drainage, EUS-guided hepaticogastrostomy, EUS-HGS

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Correspondence to:
Takeshi Ogura
Endoscopy Center, Osaka Medical and Pharmaceutical University, Osaka, Japan

2nd Department of Internal Medicine, Osaka Medical and Pharmaceutical University, 2-7 Daigakuchou, Takatsukishi, Osaka 569-8686, Japan
oguratakeshi0411@yahoo.co.jp

Kimi Bessho
Saori Ueno
Atsushi Okuda
Nobu Nishioka
Jun Sakamoto
Yoshitaro Yamamoto
Yuki Uba
Mitsuki Tomita
Nobuhiro Hattori
Junichi Nakamura
Hiroki Nishikawa
2nd Department of Internal Medicine, Osaka Medical and Pharmaceutical University, Takatsuki, Osaka, Japan

Introduction

Biliary drainage under endoscopic retrograde cholangiopancreatography (ERCP) is the gold standard technique that is usually attempted for treatment of biliary obstruction. However, if duodenoscope insertion into the duodenum is challenging due to surgically altered anatomy or duodenal obstruction, ERCP itself might be difficult. Percutaneous transhepatic biliary drainage (PTBD) is traditionally attempted as the alternative method of biliary drainage. Because PTBD has several disadvantages, including external drainage, endoscopic ultrasound-guided biliary drainage (EUS-BD) has emerged.[1–4] Of the EUS-BD techniques, EUS-guided transhepatic biliary drainage such as hepaticogastrostomy

(HGS) can be performed in patients for whom ERCP is contraindicated. Although EUS-HGS has clinical impact, it carries the risk of bile leakage from the puncture site if the procedure fails. Therefore, EUS-HGS should be successfully performed after bile duct puncture. Various guidewire insertion techniques, novel dedicated dilation devices, and self-expandable metal stents have been reported to date.[5–11] Most previous reports have focused mainly on guidewire insertion, tract dilation, or stent deployment, and have not provided technical tips for device insertion. To improve the technical success rate of device insertion without unnecessary tract dilation, the pushing force should be transmitted directly from the channel of the echoendoscope to the intrahepatic bile duct. We therefore developed a novel technique, termed the 'moving scope technique', and describe its technical feasibility during EUS-HGS.

Patients and methods

This retrospective study included patients who underwent EUS-HGS between April 2019 and September 2022. All study protocols were approved by the institutional review board of our hospital. The inclusion criteria were EUS-HGS at B3 using a 19G needle and a metal stent with an 8.5Fr stent delivery system (Niti-S D type or Spring Stopper; Taewoong Medical, Seoul, Korea), and procedural video recording cases. The exclusion criteria were EUS-HGS using a 22G needle, using a drill dilator, B2 puncture, and placement of a metal stent with a fine-gauge stent delivery system or plastic stent. Compared with B3 puncture, a stent delivery system may be more easily inserted without tract dilation, although B2 puncture has a risk of transesophageal puncture. Therefore, B2 puncture was excluded in this study. Our study followed the STROBE guideline.

Technical tips for EUS-HGS and procedure protocol

All procedures were performed by three experienced endoscopists (TO, SU, AO) who had performed more than 150 EUS-HGS procedures each. An echoendoscope (UCT260; Olympus Optical, Tokyo, Japan) was inserted into the stomach, and the intrahepatic bile duct was identified. The intrahepatic bile duct was punctured using a 19G needle [EZ shot 3 plus, Olympus, Tokyo, Japan; Figure 1(a)], and a 0.025-inch guidewire (VisiGlide 1; Olympus) was inserted into the biliary tract through the 19G needle. Insertion of a dilation device was then attempted using an ERCP catheter (MTW Endoskopie, Düsseldorf, Germany), a 4-mm balloon catheter (REN biliary balloon catheter; KANEKA, Osaka, Japan), or an ultra-tapered mechanical dilator [ES dilator; Zeon Medical Inc., Tokyo, Japan; Figure 1(b)]. The choice of device was decided by the operator endoscopist. After tract dilation, metal stent deployment was attempted [Figure 1(c)]. After successful insertion of the stent delivery system into the intrahepatic bile duct, stent release was carefully performed from the intrahepatic bile duct to the echoendoscope channel up to 3 or 4 cm, and stent release was performed entirely under endoscopic visualization [Figure 1(d)].

If the dilation device could not be inserted into the intrahepatic bile duct, the moving scope technique was attempted. As shown in Figure 2(a) and (b), if the angle between the intrahepatic bile duct and the guidewire is acute, the pushing force can be misdirected toward the foot side. Therefore, insertion of the device and the stent delivery system can be challenging. However, if the angle is obtuse, as shown in Figure 2(c) and (d), the pushing force can be transmitted directly toward the hepatic hilum. In the moving scope technique, this angle can be adjusted. First, the guidewire is deployed sufficiently within the biliary tract. If the dilation device cannot be inserted into the biliary tract, the echoendoscope is then pushed gently toward the foot side about 2–5 cm (Figure 3) and the angle between the intrahepatic bile duct and the guidewire becomes obtuse, which makes insertion of the dilation device easier (Supplemental Video; https://d.kuku.lu/bdp-8cxfr6). During performance of the moving scope technique, maintaining continuous visualization of the guidewire is important to prevent an inadequate axis. The angle of the intrahepatic bile duct to the guidewire was measured independently by three endoscopists (KB, TO, and SU) on a fluoroscopic image.

Definitions and statistical analysis

The primary outcome of this study was the technical success rate of dilation device insertion without electrocautery dilation after use of the moving scope technique. The initial technical

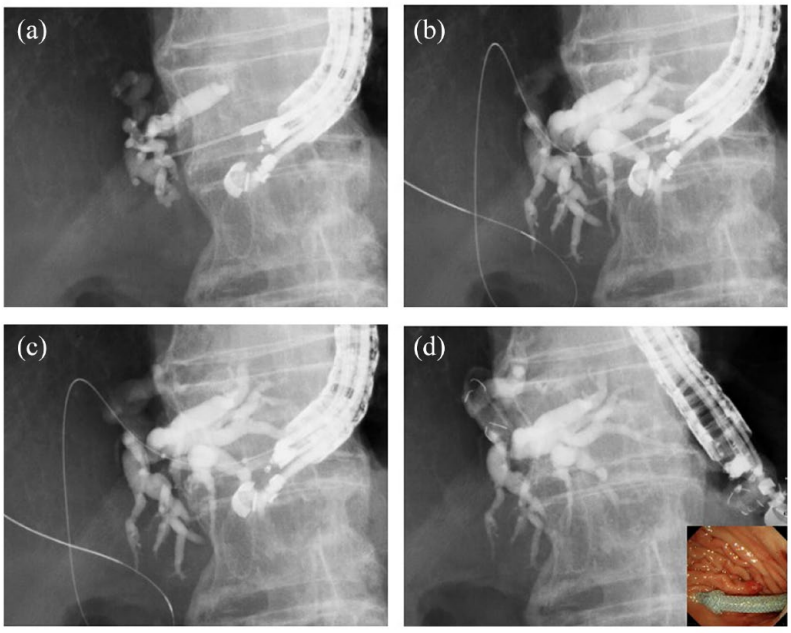

Figure 1. (a) The intrahepatic bile duct is punctured using a 19G needle, and the contrast medium is injected. (b) The 0.025-inch guidewire is deployed into the biliary tract. (c) The bile duct and stomach wall are dilated using a mechanical dilator. (d) A partially covered self-expandable stent is deployed from the intrahepatic bile duct to the stomach.

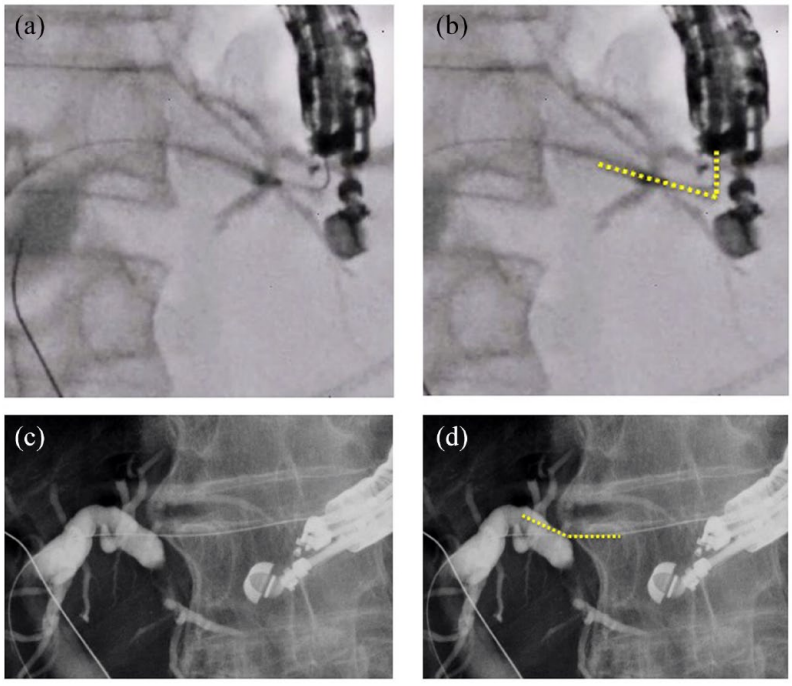

Figure 2. (a) The angle between the intrahepatic bile duct and the guidewire is acute. (b) The angle is 75° on the fluoroscopic image. (c) The angle between the intrahepatic bile duct and the guidewire is obtuse. (d) The angle is 156° on the fluoroscopic image.

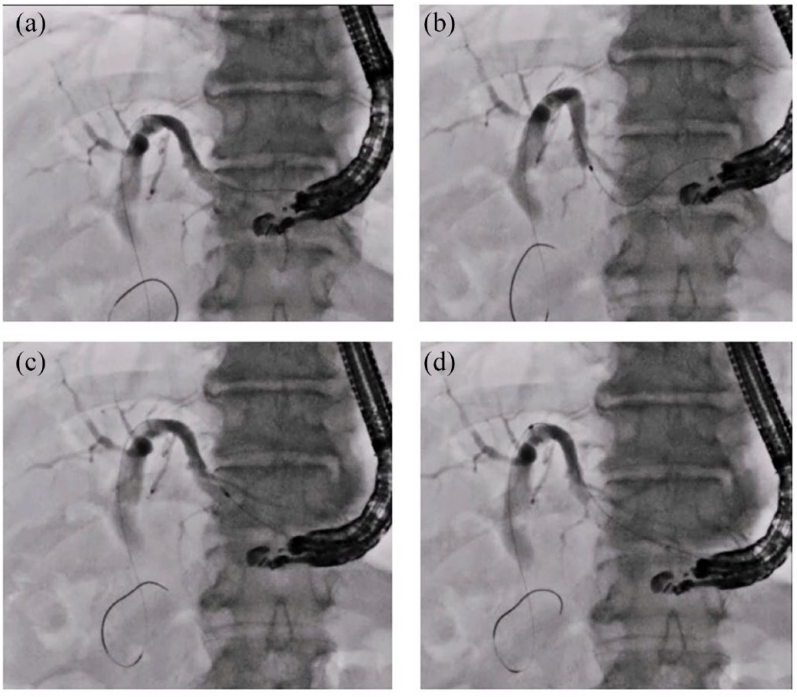

Figure 3. (a) The angle between the intrahepatic bile duct and the guidewire is 131.7°. (b) The endoscopic retrograde cholangiopancreatography catheter cannot be inserted into the biliary tract. (c) The echoendoscope is pushed gently toward the foot side. As a result, the angle between the intrahepatic bile duct and the guidewire is increased to 180°. (d) The endoscopic retrograde cholangiopancreatography catheter is successfully inserted into the biliary tract.

success rate of dilation device insertion was defined as successful insertion into the biliary tract. If dilation device insertion failed, the moving scope technique was attempted. Technical success of the moving scope technique was defined as an increase in the angle between the intrahepatic bile duct and the guidewire after application of the moving scope technique over 10°, compared with the angle prior to application of the moving scope technique. The secondary outcomes were adverse events associated with EUS-HGS, such as intraoperative bleeding; the procedure time was measured from echoendoscope insertion to successful stent deployment. Intraoperative bleeding was defined as a puncture-site hematoma with continuous bleeding that required endoscopic and/or intravenous and/or surgical hemostasis around the puncture site. Bile peritonitis was diagnosed if fever, elevated inflammatory markers on blood examination, or abdominal pain were observed within 1 day after EUS-HGS. Bile peritonitis was diagnosed as the finding of a bile leak or peritonitis around the HGS stent on computed tomography performed the day after EUS-HGS. Adverse events associated with EUS-HGS procedures were evaluated according to the severity grading system of the American Society for Gastrointestinal Endoscopy lexicon.[12] Descriptive statistics are presented as mean ± standard deviation (SD) or median and range values for continuous variables and as frequencies for categorical variables. Receiver-operating characteristic (ROC) curves were created to assess the effect of the angle of dilation device insertion and to determine the optimal cutoff for such success. All data were statistically analyzed mainly using SPSS version 13.0 statistical software (SPSS, Chicago, IL, USA).

Results

Table 1 shows the patient's characteristics. A total of 143 patients (median age 72 years; 94 males, 46 females) were enrolled in this study. The primary disease was pancreatic cancer ($n = 50$), cholangiocarcinoma ($n = 21$), hepaticojejunostomy stricture ($n = 20$), bile duct stone ($n = 22$), gastric cancer ($n = 10$), duodenal cancer ($n = 5$), and other ($n = 15$). EUS-HGS was performed for treatment of duodenal obstruction

Table 1. Patient characteristics.

Total patients (*n*)	**143**
Median age (year, range)	72 (48–93)
Sex (male:female)	94/46
Disease, *n*	
Pancreatic cancer	50
Cholangiocarcinoma	21
Hepaticojejunostomy stricture	20
Bile duct stone	22
Gastric cancer	10
Duodenal cancer	5
Gallbladder cancer	5
Others	10
Reason for EUS-HGS	
Duodenal invasion	75
Surgical altered anatomy	67
Failed biliary cannulation	1
Kinds of initial dilation device	
Balloon	36
Mechanical dilator	19
ERCP catheter	88
Mean diameter of the puncture site, mm (±SD)	4.5 ± 2.3
Mean procedure time, min (±SD)	14.2 ± 9.0

ERCP, endoscopic retrograde cholangiopancreatography; EUS-HGS, endoscopic ultrasound-guided hepaticogastrostomy; SD, standard deviation.

Table 2. Analysis of factors associated with successful device insertion.

Initial technical success rate of device insertion, % (*n*)	**80.4 (115/143)**
Technical success of MST, % (*n*)	100 (28/28)
Technical success rate of device insertion without electrocautery dilation after MST, % (*n*)	96.4 (27/28)
Overall technical success rate of device insertion without electrocautery dilation, % (*n*)	99.3 (142/143)
Mean angle between the IHBD and guidewire, overall (±SD)	128.6 ± 30.3
Mean angle between the IHBD and guidewire in failed cases (±SD)	89.0 ± 22.5
Mean angle between the IHBD and guidewire in failed cases after MST (±SD)	141.0 ± 22.6
Kinds of adverse events, *n*	
Without MST group	
Bile peritonitis	5
Cholangitis	1
MST group	
Bile peritonitis	3
Cholangitis	1

IHBD, intrahepatic bile duct; MST, moving scope technique; SD, standard deviation.

(*n* = 75), surgically altered anatomy (*n* = 67), and failed biliary cannulation (*n* = 1). The initial dilation devices used were an ERCP catheter (*n* = 88), balloon catheter (*n* = 36), and mechanical dilator (*n* = 19). The mean diameter of the puncture site was 4.5 mm, and procedure time was 14.2 min.

Table 2 shows the results of the procedures. The mean angle between the intrahepatic bile duct and the guidewire was 128.6°. The initial technical success rate for device insertion without electrocautery dilation was 80.4% (115/143). The initial procedure failed in 28 patients, using an ERCP catheter (*n* = 20), mechanical dilator (*n* = 5), and balloon catheter (*n* = 3). In the 28 patients for whom the procedure failed, the mean angle between the intrahepatic bile duct and the guidewire during initial device insertion was 89.0°. The moving scope technique was attempted in all 28 of these patients, which improved the mean angle between the intrahepatic bile duct and the guidewire to 141.0° and resulted in a technical success rate of 100% (28/28). Following implementation of the moving scope technique, the dilation device without electrocautery dilator was inserted successfully in 27 patients. The remaining patient underwent tract dilation using an electrocautery dilator due to failed dilation device insertion even with the moving scope technique. This patient had frequent cholangitis due to a hepaticojejunostomy stricture, and, therefore, the bile duct wall was extremely hard. Finally, metal stent deployment was successful in

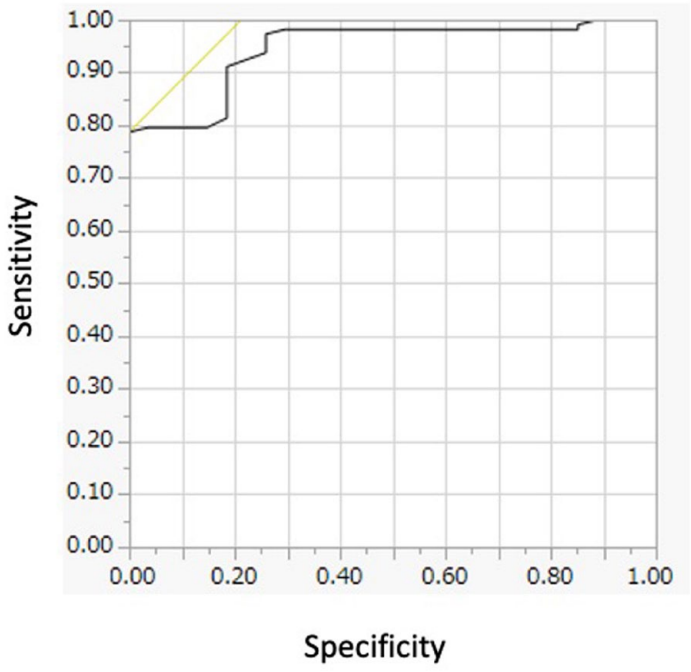

Figure 4. The area under the ROC curve (AUC) is 0.88, and 120° offers sensitivity of 88.0% and specificity of 78.8% for predicting successful dilation device insertion.
ROC, Receiver-operating characteristic.

all patients. As adverse events, bile peritonitis ($n=8$) and cholangitis ($n=2$) were observed, and the frequency of these adverse events did not differ between the non-moving scope technique group and the moving scope technique group. All adverse events were successfully managed by conservative treatment.

The effect of the angle between the intrahepatic bile duct and the guidewire on the success of dilation device insertion was assessed using ROC curve analysis (Figure 4). The area under the ROC curve (AUC) was 0.88, and 120° offered sensitivity of 88.0% and specificity of 78.8% for predicting successful dilation device insertion.

Discussion

The objective of the EUS-HGS procedure is to deploy the stent from the intrahepatic bile duct to the stomach. Various dedicated stents are available for EUS-HGS, including plastic stents.[13] A study that compared metal and plastic stents found that bile leakage can occur from the fistula because of the gap between the stent and fistula. On the other hand, a metal stent has a self-expandable function, therefore, a tamponade effect on the fistula can be obtained, and bile leakage from the fistula can be prevented. Therefore, metal stents may be preferable in terms of preventing bile leakage. Tract dilation is usually necessary for deployment of a metal stent. Yagi *et al.* compared the feasibility of metal stent deployment between a dilation group using a balloon catheter and a non-dilation group.[14] In their study, 17 and 21 patients were enrolled in the dilation and non-dilation groups, respectively. The technical success rate of stent deployment after initial dilation was 100% (17/17) in the dilation group and 71.4% (15/21) in the non-dilation group ($p=0.024$). Therefore, except for stents with a fine-gauge stent delivery system,[15] it may be necessary to perform tract dilation prior to stent delivery system insertion. In addition, EUS-guided antegrade stenting (AS) and antegrade intervention have been developed.[16–19] To perform these procedures, the guidewire should be manipulated and deployed across the stricture site using an ERCP catheter. Therefore, the ERCP catheter should be inserted into the biliary tract across the stomach and bile duct wall. If this is not possible, then tract dilation is necessary using a dilation device such as a balloon catheter or electrocautery dilator. However, since bile

leakage from the fistula can occur after tract dilation, the risk of adverse events such as bile peritonitis may also increase. Therefore, there is a clinical need for improvement in the technical success rate of initial device insertion.

Several efforts have been reported in this regard, including some that have evaluated the angle between the guidewire or the needle and the biliary tract during EUS-HGS.[20,21] Ohno *et al.* reported the feasibility and efficacy of EUS-HGS without dilation using a propensity score matching analysis.[21] They did not include ERCP catheters among the dilation devices, and the focus was on the angle between the needle and the puncture site. A total of 74 patients who underwent successful EUS-HGS (dilation group, $n=35$, non-dilation group, $n=34$) were included According to the ROC curves, an angle of 90° had sensitivity of 51.4% and specificity of 94.6% for predicting the need for dilation. Using this factor, they found that plastic stent placement (OR, 6.96; 95% CI, 1.68–28.7; $p=0.007$) and puncture angle (OR, 44.6; 95% CI, 5.1–390; $p<0.001$) were factors significantly associated with dilation according to multivariate analysis. Although this result for puncture angle is interesting, the angle may have a large influence on successful guidewire insertion because after guidewire deployment, the angle between the intrahepatic bile duct and the guidewire can change due to the stiffness of the guidewire itself. In addition, in clinical practice, ERCP catheter insertion is generally performed for guidewire deployment at an adequate and stable site; or EUS-AS, as mentioned above. Fujii *et al.* evaluated the efficacy of the double guidewire technique for EUS-HGS.[21] They evaluated the association between the guidewire angle at the puncture site and successful ERCP catheter insertion. According to multivariate analysis using various factors, a guidewire angle at the insertion site of $>137°$ ($p=0.013$) and the use of a double lumen cannula ($p=0.04$) were significant factors associated with successful ERCP catheter insertion. This angle also affected the need for tract dilation. A guidewire angle of $\leqslant 137°$ (OR, 35.6; 95% CI, 1.70–744; $p=0.0045$) and diameter of the intrahepatic bile duct of $\leqslant 13.0$ mm (OR, 14.4; 95% CI, 1.37–152; $p=0.0056$) were risk factors associated with additional tract dilation. In the present study, an angle of $>120°$ between the intrahepatic bile duct and the guidewire was adequate for insertion of dilation devices, and an angle of up to 140° was achieved after applying the moving scope technique. The similarity of the present results with these previous studies suggests the reliability of our technique. Previous studies have focused on risk factors but have not described a rescue method. The moving scope technique may be used as a rescue method in the case of failed device insertion, which may also reduce the procedure time because dilation device exchange is not necessary, and it may save the cost of device exchange.

The present study has several limitations, including its retrospective design and lack of historical controls; therefore, further randomized controlled trials are necessary with a larger cohort. Sometimes, during EUS-HGS, the guidewire cannot be sufficiently inserted. In such cases, using this technique might result in the guidewire deviating. In such cases, moving scope technique should not be applied.

In conclusion, the moving scope technique may be helpful during EUS-HGS to achieve successful insertion of the dilation device into the biliary tract. These results should be evaluated in a prospective randomized controlled trial.

Declarations

Ethics approval and consent to participate

All study protocols were approved by the institutional review board of our hospital. The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki as reflected in the a priori approval given by the human research committee of Osaka Medical College (IRB No. 2022-117).

Consent for publication

Not applicable.

Author contributions

Kimi Bessho: Writing – original draft; Writing – review & editing.

Takeshi Ogura: Formal analysis; Writing – original draft; Writing – review & editing.

Saori Ueno: Data curation; Visualization.

Atsushi Okuda: Data curation.

Nobu Nishioka: Data curation.

Jun Sakamoto: Data curation.

Yoshitaro Yamamoto: Data curation.

Yuki Uba: Data curation.

Mitsuki Tomita: Data curation.

Nobuhiro Hattori: Data curation.

Junichi Nakamura: Data curation.

Hiroki Nishikawa: Writing – review & editing.

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Competing interests
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ORCID iD
Takeshi Ogura https://orcid.org/0000-0003-2916-6568

Supplemental material
Supplemental material for this article is available online.

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