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MINIREVIEWS

Technical tips for endoscopic ultrasound-guided hepaticogastrostomy

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Abstract

Interventional procedures using endoscopic ultrasound (EUS) have recently been developed. For biliary drainage, EUS-guided trans-luminal drainage has been reported. In this procedure, the transduodenal approach for extrahepatic bile ducts is called EUS-guided choledochoduodenostomy, and the transgastric approach for intrahepatic bile ducts is called EUS-guided hepaticogastrostomy (EUS-HGS). These procedures have several effects, such as internal drainage and avoiding post-endoscopic retrograde cholangiopancreatography (ERCP) pancreatitis, and they are indicated for an inaccessible ampulla of Vater due to duodenal obstruction or surgical anatomy. EUS-HGS has particularly wide indications and clinical impact as an alternative biliary drainage method. In this procedure, it is necessary to dilate the fistula, and several devices and approaches have been reported. Stent selection is also important. In previous reports, the overall technical success rate was 82% (221/270), the clinical success rate was 97% (218/225), and the overall adverse event rate for EUS-HGS was 23% (62/270). Adverse events of EUS-biliary drainage are still high compared with ERCP or PTCD. EUS-HGS should continue to be performed by experienced endoscopists who can use various strategies when adverse events occur.

Key words: Endoscopic ultrasound; Endoscopic ultrasound-guided hepaticogastrostomy; Endoscopic ultrasound-guided biliary drainage; Endoscopic retrograde cholangiopancreatography

Core tip: Endoscopic ultrasound-guided hepaticogastrostomy (EUS-HGS) has been developed as an alternative biliary drainage method. The reported technical success rate of EUS-HGS ranges from 65% to 100%, and the clinical success rate ranges from 87% to 100%. Furthermore, the overall technical success rate was 82%, and the overall clinical success rate was 97%. Based on the currently available literature, the overall adverse event rate for EUS-HGS is 23%. EUS-HGS has high rate of adverse events that are sometimes fatal. Therefore, EUS-HGS should continue to be performed by experienced endoscopists who can

use various strategies when adverse events occur.

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INTRODUCTION

Biliary drainage under endoscopic retrograde cholangiopancreatography (ERCP) guidance has been well established and widely performed[1,2]. The technical success rate of this procedure is high according to previous reports. If ERCP fails, percutaneous transhepatic biliary drainage (PTBD) is conventionally attempted. PTBD is also established as an alternative drainage method. However, this procedure has several disadvantages, such as catheter dislodgement, pneumothorax, external drainage, and cosmetic problems[3-5]. Recently, interventional procedures using endoscopic ultrasound (EUS) have been developed. For biliary drainage, EUS-guided transluminal drainage has been reported (EUS-guided biliary drainage; EUS-BD). The transduodenal approach for extrahepatic bile ducts is called EUS-guided choledochoduodenostomy (EUS-CDS)[6-8], and the transgastric approach for intrahepatic bile ducts is called EUS-guided hepaticogastrostomy (EUS-HGS). For EUS-BD, EUS-HGS can be performed if the duodenal bulb is obstructed due to malignant tumor. The technical success rate has been high, however, the rate of adverse events has also been reported to be high.

Table 1 shows an overview of recent published reports of EUS-HGS (over 10 cases, and excluding insufficient data)[9-19]. In this paper, previous reports are reviewed, and technical tips for EUS-HGS to ensure successful performance and avoid adverse events are presented.

INDICATIONS

To date, EUS-BD is seen as a consistent alternative drainage method. Therefore, as well as other EUS-BD procedures, EUS-HGS should also be indicated for failed ERCP due to surgical anatomy and an inaccessible ampulla of Vater. Although EUS-CDS is contraindicated in patients with surgically altered anatomy, such as a Roux-en-Y anastomosis or duodenal bulb obstruction caused by tumor invasion, EUS-HGS can be performed because this procedure is performed from the stomach. With respect to a biliary stricture, if the hepatic hilum is obstructed, EUS-HGS may be contraindicated, because with stent placement in the left intrahepatic bile duct, the right hepatic bile duct cannot drain**.** Recently, EUS-BD for right hepatic biliary obstruction has been reported as an expanding indication[20,21]. Park *et al*[20] reported that, among 6 patients who had isolated right hepatic bile duct obstruction, EUS-guided access successfully resulted in antegrade bypass stenting in 2 patients, antegrade transanastomotic stenting in 1 patient, antegrade transanastomotic balloon dilation in 1 patient, and a cholangiogram as a roadmap in 1 patient. We also reported[21] that, among 11 patients with right hepatic bile duct obstruction, EUS-BD was successfully performed from the left hepatic approach (bridging method) in 7 patients and from the right hepatic approach (locking stent method) in 4 patients. Remarkably, no adverse events were reported in both papers. Therefore, EUS-HGS may be indicated for hepatic hilar obstruction. However, because this technique is challenging, the right hepatic approach using EUS-BD should be performed for limited cases.

Recently, Khashab *et al*[22] reported a comparative evaluation of EUS-BD and PTCD in patients with distal malignant biliary obstruction. In this report, although the technical success rate was higher in the PTCD group (100% *vs* 86.4%, $P = 0.007$), clinical success and stent patency were the same. In addition, the adverse event rate (70.6% *vs* 18.2%, $P < 0.001$) and total charges were higher in the PTCD group ($9.072 ± 3.817 *vs* $18.261 ± 16.021, $P = 0.003$). Therefore, they concluded that EUS-BD should be selected if the procedure can be performed by experienced endoscopists. However, this study has several limitations, such as a small number of patients in a single center with a single operator. To determine whether EUS-HGS or PTCD should be performed as an alternative drainage method, a multicenter, prospective, randomized, controlled trial is needed.

Hence, the following are the indications for EUS-HGS: (1) Failed ERCP; (2) Inaccessibility of the ampulla of Vater, including due to surgical anatomy and tumor invasion; and (3) Contraindications for PTCD such as ascites and possibility of self-tube removal.

On the other hand, compared with PTCD, metallic stent placement is performed in EUS-HGS; therefore, if a small amount of ascites is present between the stomach and liver, EUS-HGS may be indicated. However, if massive ascites is present, preventing the formation of a fistula between the stomach and the liver, EUS-HGS is not indicated. For patients with unresectable gastric cancer, because the stomach volume is decreased due to tumor growth, the EUS-HGS stent might be pulled into the stomach (Figure 1).

Hence, the following are the contraindications for EUS-HGS: (1) Massive ascites between the stomach and the liver; and (2) Unresectable gastric cancer.

DEVICE SELECTION AND TECHNICAL TIPS

Puncture of the intrahepatic bile duct

To visualize the left intrahepatic bile duct, EUS should

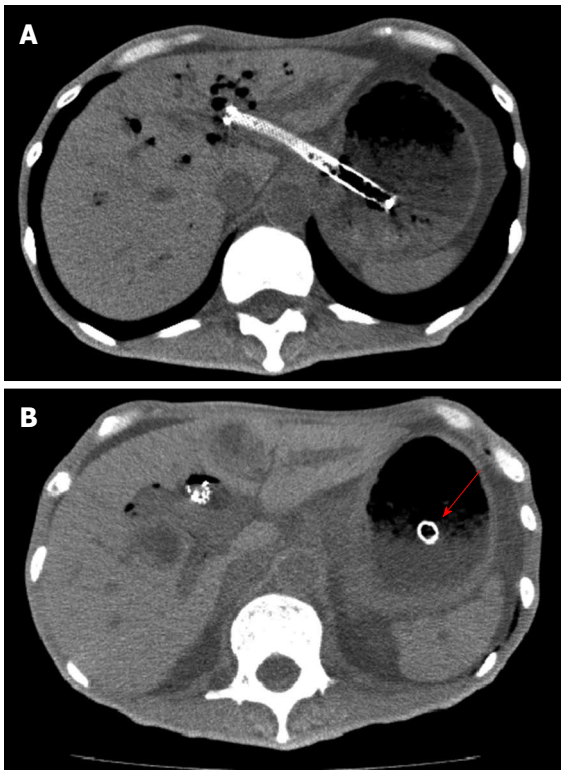

Figure 1 Dislocation of endoscopic ultrasound-guided hepaticogastrostomy metallic stent. (A) EUS-HGS was performed for gastric cancer patient. (B) Because of tumor growth, dislocation of EUS-HGS metallic stent was seen (arrow). EUS-HGS: Endoscopic ultrasound-guided hepaticogastrostomy.

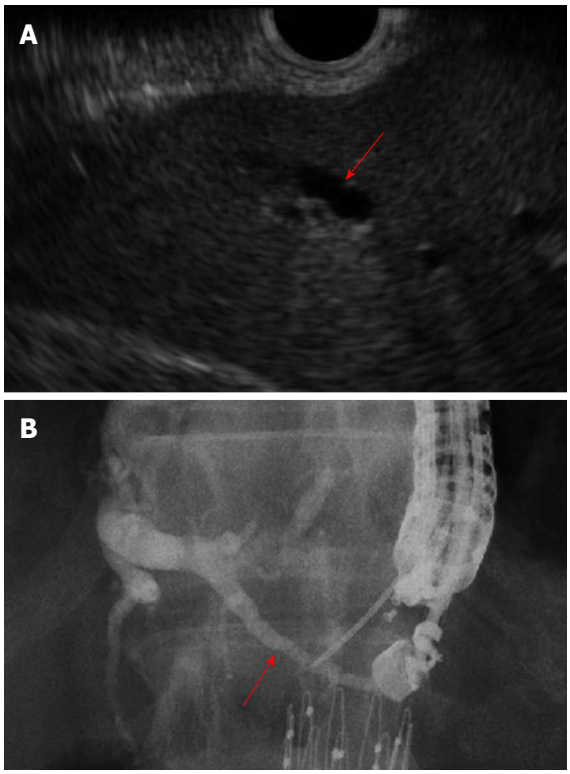

Figure 2 Technical tips of puncture on endoscopic ultrasound-guided hepaticogastrostomy. (A) To advance the guidewire toward the hepatic hilum, the bile duct that runs from the upper left to the lower right on EUS imaging should be punctured (arrow) (B) fluoroscopic imaging (arrow). EUS-HGS: Endoscopic ultrasound-guided hepaticogastrostomy.

be advanced into the stomach. Then, using slight counter clockwise rotation, the left hepatic lobe can be visualized. A 19G-FNA needle is better than a 22G-FNA needle. A stiffer guidewire can be inserted through the FNA needle, because a dilation fistula is more needed to insert the stent delivery system than with EUS-CDS. If segment 2 (B2) is punctured, because each device is passed through the mediastinum when puncturing from the esophagus, severe adverse events, such as mediastinitis or pneumomediastinum, may occur. Therefore, on EUS-HGS, segment 3 (B3) should be initially selected as the puncture site. To puncture the intrahepatic bile duct, there are two important points. One is the angle of the bile duct, and the other is the volume of liver parenchyma.

To advance the guidewire toward the hepatic hilum, the bile duct that runs from the upper left to the lower right on EUS imaging should be punctured (Figure 2). Furthermore, to avoid stent migration, sufficient volume of liver parenchyma is needed, as for the PTCD procedure**.** Therefore, for these reasons, B3 is better for puncturing the biliary tract.

Guidewire insertion into the hepatic hilum or common bile duct

Guidewire insertion is one of most important procedures during EUS-HGS. If the guidewire is advanced into the peripheral biliary tract, the next step, such as dilation device or stent delivery system insertion, cannot be performed. To successfully advance the guidewire toward the hepatic hilum, as described in the puncture of the intrahepatic bile duct section, the biliary tract running from the upper left to the lower right on EUS imaging should be punctured. If the guidewire is advanced into the peripheral biliary tract, the guidewire should be pulled, and then one should try to advance the guidewire into the hepatic hilum. However, during this procedure, the guidewire is sometimes kinked with the FNA needle. To avoid this adverse event, the liver impaction method is useful[23].

Various types of guidewires are available. A 0.025-inch guidewire with a highly flexible tip, sufficient stiffness, and easy seeking ability (VisiGlide, Olympus Medical Systems, Tokyo, Japan) is preferable for the EUS-guided procedure. After the guidewire is inserted along with other devices, it is important to keep visualizing the other devices on EUS imaging during various EUS-guided procedures to fit the axis.

Devices used to dilate the fistula

To insert the stent delivery system, the bile duct and stomach wall must be dilated. To date, various techniques of dilating a fistula have been reported (Table 1). According to previous reports, a graded dilation technique using a dilator or a 4-mm balloon catheter is used by many authors. The dilator (6 to 10 Fr; Soehendra biliary dilation catheters, Cook Medical), balloon catheter (4-8 mm; MaxForce or Hurricane

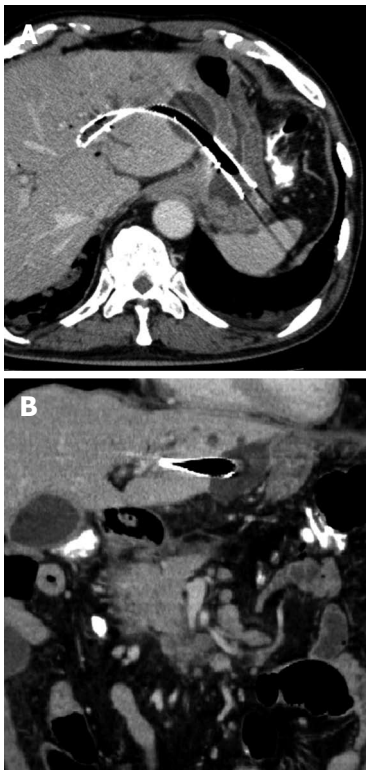

Figure 3 Biloma after endoscopic ultrasound-guided hepaticogastrostomy. Long procedure time was needed, therefore, bile leak was increased.

RX; Boston Scientific), and needle knife (Microtome, Boston Scientific) are most used by many authors.

Park *et al*[9] reported that, among total 57 consecutive patients, post procedure adverse events occurred in 11 patients (bile peritonitis *n* = 2, mild bleeding *n* = 2, self-limited pneumoperitoneum *n* = 7). On multivariate analysis, using a needle knife was the only risk factor for post procedure adverse events of EUS-BD (P = 0.01, HR = 12.4, 95%CI: 1.83-83.5). They concluded that a needle knife should not be used as a dilation device if possible. To avoid this risk, a diathermic dilator (Cysto Gastro Set; Endoflex, GmbH, Voerde, Germany) has recently become available. This device is always coaxial with the guidewire. Although this device has clinical impact as a dilation device, a burning effect can occur. When the bile duct is punctured avoiding small vessels of the stomach or bile duct wall, bleeding may occur due to the burning effect of the diathermic dilator.

On the other hand, a graded dilation technique using a balloon or dilator catheter may be safe. Park do *et al*[24] reported that graded dilation using a 4-Fr cannula and 6-Fr and 7-Fr bougie dilators is safe. In their study, technical success of EUS-CDS was relatively high, with a low rate of adverse events. In our previous report[25], we successfully performed EUS-HGS using an ERCP catheter and a 4-mm balloon catheter without using a needle knife or cystotome. This technique may be associated with a lesserfrequency of bleeding caused by the burning effect of a needle knife or diathermic dilator, but bile leakage may easily occur during graded dilation. Recently, novel techniques and dilation devices for EUS-BD have been reported. Paik *et al*[15] reported a simplified fistula dilation technique. After the biliary tract was punctured using a 19G FNA needle, direct insertion using a 4-mm balloon catheter (Hurricane RX; Boston Scientific) was performed. In 28 patients, technical success of creating a dilation fistula using this technique was 96% (27/28). In addition, no early adverse events were seen. We also reported a simplified fistula dilation technique using a novel balloon catheter[26,27]. As an even more novel technique, a one-step stent placement technique has been reported[19]. In this study, 32 patients with malignant biliary obstruction were enrolled, and EUS-BD using a novel metallic stent was attempted. The introducer for this novel stent has only a 3-Fr-tip-4-Fr tapered. Technical success of one-step stent placement without any additional dilation was 88% (14/16). In addition, the procedure time was short in the one-step stent placement group. With a longer procedure time, the possibility of bile leakage may be increased (Figure 3). Indeed, in their study, compared with the graded dilation group, although significant differences were not seen, early adverse events were uncommon in the one-step dilation group (31.3% *vs* 6.3%, P = 0.172). Although randomized, clinical trials and additional cases are needed for which dilation technique or devices are more suitable, simplified dilation technique or one-step stent placement technique using novel metallic stents may decrease the frequency of adverse events such as bile leakage.

Stent selection

According to previous reports, a fully covered self-expandable metallic stent (FCSEMS) was mainly used (Table 1). An FCSEMS may be more suitable for EUS-HGS than a plastic stent for the following reasons: (1) If a large fistula is created to insert the stent delivery system, bile leakage is less likely from the gap between the stent and fistula[28-30]; (2) Longer stent patency may be obtained; (3) A tamponade effect of the FCSEMS itself will occur if there is bleeding from the stomach wall[17].

Also, there are several disadvantages of FCSEMS, as follows: (1) Expensive; (2) Stent shortening must be considered, especially the luminal portion to prevent stent migration[17]; and (3) Side branches of the left hepatic biliary tract may be obstructed.

Recently, a novel metallic stent and several efforts to prevent stent migration have been reported. With the use of the standard metallic stent, some authors reported that a double pigtail plastic stent can be placed inside the metal stent, with the pigtail functioning as an anchor[31]. To prevent proximal stent migration, sufficient stent length is needed. We also previously reported that EUS-HGS could be safety performed using a long and partially covered metallic stent[25,32]. More recently, Song *et al*[14] published a preliminary report on a hybrid metal stent for EUS-

Table 1 Overview of recent published reports on endoscopic ultrasound-guided hepaticogastrostomy (over 10 cases, excluding insufficient data) *n* (%)

Ref.	Technical success	Clinical success	Dilation devise	Stents	Adverse events (*n*)
Park *et al*[9], 2011	31 (100)	27 (87)	4Fr cannula, 6Fr, 7Fr biliary dilator, needle-knife	PS, Fully CSEMS	Pneumoperitoneum (6)
Vila *et al*[10], 2012	22 (65)	22 (100)	NA	NA	Bleeding (3), biloma (4), perforation (4), liver hematoma (2), abscess (1)
Attasaranya *et al*[11], 2012	11 (85)	11 (100)	ERCP cannula, 6Fr, 7Fr biliary dilator, needle-knife	Pig PS Fully CSEMS	Minor adverse events (5) Major adverse events (1)
Prachayakul *et al*[12], 2013	NA	NA	Tapered tip Teflon catheter	Fully CSEMS	NA
Kawakubo *et al*[13], 2013	19 (95)	NA	Biliary dilation catheter, dilating balloon, cautery dilator	Straight PS, CSEMS	Bile leakage (2) Stent migration (2) Bleeding (1) Cholangitis (1) Biloma (1)
Song *et al*[14], 2014	10 (100)	10 (100)	6Fr, 7Fr biliary dilator, needle-knife, 4-mm dilating balloon	Hybrid metal stent	Pneumoperitoneum (2) minor bleeding (1)
Paik *et al*[15], 2014	27 (96)	24 (89)	4-mm balloon	Dual-flap Fully CSEMS	Migration (1) Pseudoaneurysm (1)
Artifon *et al*[16], 2015	24 (96)	22 (91)	Dilating catheter, needle-knife	Partially CSEMS	Minor bleeding (3) Biloma (1) Bacteremia (1)
Umeda *et al*[17], 2015	23 (100)	23 (100)	Standard or tapered catheter, cautery dilator, 8Fr dilation catheter, 4-mm balloon	8Fr single-plastic stent	Bleeding (1), self-limited abdominal pain (3)
Poincloux *et al*[18], 2015	65 (99)	61/65 (94)	5.5Fr needle-knife, 6Fr, 7Fr dilation catheter	10Fr PS Fully CSEMS Two fitting CSEMS Half covered SEMS	Pneumoperitoneum (2) Intrahepatic hematoma (1) Bile leakage (5) Sever sepsis (2)
Park *et al*[19], 2015	20 (100)	18/20 (90)	Without dilation, 4-mm balloon catheter, dilation catheter	CSEMS with dedicated stent introducer, fully CSEMS	Mild adverse events (2) Moderate adverse events (3)

PS: Plastic stent; CSEMS: Covered self-expandable metallic stent; NA: Not available.

BD. The distal portion of this novel stent, which is 3.5 mm long, is composed of silicone-covered nitinol wire to prevent bile leakage. In addition, proximal and distal of the covered site there are anti-migration flaps to prevent stent migration. This novel stent has the uncovered site on the proximal site, which is 1.5 to 5.5 mm long, to prevent obstruction of side branches. In their study using this novel stent, EUS-HGS was successfully performed for all patients (n = 10), and, in addition, stent migration or bile leakage was not seen.

On the other hand, EUS-HGS using a newly designed plastic stent has been reported by Umeda *et al*[17]. In their study, an 8-Fr single-pigtail plastic stent, which is a pus-type stent that is usually not possible to retract, with a total of 20 cm and an effective length of 15 cm with 4 flanges, was used. The proximal end has a pigtail stricture**,** and the distal end is tapered. EUS-HGS using this novel plastic stent was successfully performed in 23 patients (technical success rate 100%). Although bleeding or abdominal pain was seen in 4 patients (17.4%), no severe adverse events such as stent migration or dislocation were seen during follow-up (median 5.0 mo). Stent patency was 4.0 mo (range 0.5-12.5 mo). This result was clinically encouraging, but, as the author described, additional long-term studies with a large number cases are needed to evaluate the clinical impact of using this stent for EUS-HGS.

SUCCESS RATE

The reported technical success rate of EUS-HGS ranges from 65% to 100%, and the clinical success rate ranges from 87% to 100% (Table 1). Furthermore, the overall technical success rate was 82% (221/270), and the overall clinical success rate was 97% (218/225). Compared with EUS-CDS, the technical success rate was relatively lower. This may be due to the difficulty puncturing the biliary tract and inserting the guidewire. To increase the technical success rate, devices should be improved. EUS-HGS should be still performed by experienced endoscopists at high-volume centers, because the adverse events of EUS-HGS are sometimes fatal.

ADVERSE EVENTS

Adverse events of EUS-BD are still high compared with ERCP or PTCD. Based on the currently available

literature (Table 1), the overall adverse event rate for EUS-HGS is 23% (62/270), and these adverse events, include: (1) Bleeding; (2) Pneumoperitoneum; (3) Biloma, bile leakage; (4) Infection (cholangitis, abscess, bacteremia); (5) Hematoma; (6) Perforation; (7) Abdominal pain; (8) Pseudoaneurysm; and (9) Stent migration

Among them, stent migration is recognized as a severe adverse event that is sometimes fatal. Okuno *et al*[33] reported stent migration that was treated by surgery. They used an 8-cm-long FCSEMS, and stent migration occurred immediately. Martins *et al*[34] also reported that EUS-HGS was successfully performed using an 8-mm-long, partially covered SEMS, but after 5 days, stent migration with the proximal end located within a large biloma occurred. Although conservative treatment was performed, this patient died. We also reported stent migration within the stomach wall after 3 d[25]. In addition, we also reported that stent length in the luminal portion is an important factor to reduce the adverse events of EUS-HGS[32]. Therefore, considering stent shortening, over 10 cm or a novel SEMS such as previously reported should be used to prevent stent migration[32,33].

CONCLUSION

EUS-HGS has wide indications and clinical impact as an alternative biliary drainage method. However, EUS-HGS also has a high rate of adverse events that are sometimes fatal. Therefore, EUS-HGS should continue to be performed by experienced endoscopists who can use various strategies when adverse events occur.

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