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Review

Endoscopic ultrasound-guided rendezvous techniques for difficult biliary cannulation: Technical review

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Endoscopic retrograde cholangiopancreatography (ERCP) is the standard procedure for the diagnosis and treatment of biliary diseases. However, selective biliary cannulation, the essential first step in ERCP, can sometimes fail due to anatomical variations or technical limitations. In these cases, the endoscopic ultrasound-guided rendezvous technique (EUS-RV) offers a valuable salvage option. Nevertheless, it is crucial to be aware of potential adverse events associated with bile duct puncture. To optimize the success rate and safety of EUS-RV, understanding the basic techniques, technical tips for each procedural step, and troubleshooting strategies for potential difficulties is essential. This review article summarizes the clinical outcomes and technical considerations of EUS-RV, including a comprehensive analysis of the current evidence.

Key words: cannulation, double guidewire, endoscopic retrograde cholangiopancreatography, endoscopic ultrasound-guided biliary drainage, precut

BACKGROUND

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY (ERCP) is widely performed in routine clinical practice as a minimally invasive diagnostic and therapeutic modality for biliary diseases. Selective biliary deep cannulation is the primary step of ERCP for managing these conditions. Conventional techniques typically involve a combination of ERCP cannula or sphincterotome with contrast media or guidewire to achieve biliary cannulation, demonstrating high success rates.[1] In cases where conventional methods for biliary cannulation are challenging, advanced cannulation techniques, such as the double guidewire technique[2] and the precutting technique,[3] have been considered useful salvage techniques. Nevertheless, even with the application of these techniques some situations like duodenal parapapillary diverticulum, tumor invasion in the peripapillary region, and other technical limitations can further hinder biliary cannulation. For such cases, recent reports have shown the utility of endoscopic ultrasound-guided biliary drainage (EUS-BD), where the bile duct is accessed from the upper gastrointestinal tract using EUS. In 2001, Giovannini *et al.*[4] introduced EUS-guided choledocoduodenostomy (CDS) for bile duct drainage, followed by the development of EUS-guided hepaticogastrostomy (HGS),[5] EUS-guided antegrade treatment (AG),[6] and others. EUS-guided rendezvous technique (RV) is considered one of the EUS-BD techniques and involves EUS-guided puncture of the bile duct, followed by guidance into the bile duct and a reattempt of biliary cannulation with the help of the guidewire placed under EUS guidance as a salvage technique for failed biliary deep cannulation. Mallery *et al.*[7] first reported the application of EUS-RV in 2004 for two patients with distal malignant biliary obstruction where biliary deep cannulation was difficult to achieve. Since then, EUS-BD has been well evaluated for its efficacy, safety, and new techniques and devices to improve them.[8–11] Numerous investigators have also evaluated and reported the clinical outcomes and techniques of EUS-RV.[12–28]

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OUTCOMES OF EUS-RV

A RECENT META-ANALYSIS comparing EUS-RV with percutaneous transhepatic biliary (PTB)-RV including 19 articles with 524 patients for EUS-RV and 12 articles with 591 patients for PTB-RV evaluated the technical success rate and safety.[29] The results showed that the pooled technical success rates were 88.7% (95% confidential interval [CI] 84.6–92.8%, I^2 = 70.5%) for EUS-RV and 94.1% (95% CI 91.1–97.1%, I^2 = 59.2%) for PTB-RV (P = 0.088). The pooled rates of overall adverse events were 9.8% (95% CI 7.3–12.3%, I^2 = 0%) for

EUS-RV and 13.4% for PTB-RV (95% CI 8.8–17.9%, I^2 = 59.92%; P = 0.686). Types of adverse events related to EUS-RV were pancreatitis at 2.5%, bleeding at 1.6%, cholangitis at 1.8%, bile leakage at 3.0%, and perforation at 1.9%. These results suggest that EUS-RV is useful as a salvage method after unsuccessful bile duct cannulation. However, caution should be paid for possible adverse events associated with bile duct puncture. In particular, if the procedure is unsuccessful after biliary puncture, which is the first step of EUS-RV, and the bile duct is not decompressed, which may lead to persistent bile leakage and serious adverse events. We have to know the basic techniques well, technical tips in each step of EUS-RV, and troubleshooting for possible difficulty to improve the success rate and the safety of EUS-RV. This article focuses on the technical aspects of EUS-RV, including a review of its current evidence.

BASIC TECHNIQUES OF EUS-RV

IF ERCP FAILS to achieve selective biliary deep cannulation and EUS-RV is indicated, the duodenal scope is replaced with a convex EUS scope. The bile duct is visualized from the stomach, duodenal bulb (D1), and second portion of the duodenum (D2). B-mode, as well as Doppler mode, are used to assess puncture feasibility and identify any blood vessels along the puncture route. Once the scope position and target bile duct are determined, the bile duct is punctured using a 19G fine needle aspiration (FNA) needle, where the stylet is removed and the needle is filled with a contrast agent (Fig. 1). Contrast is then injected to confirm the correct bile duct puncture and delineate the duct's shape. A 0.025 inch or 0.035 inch guidewire is inserted through the needle and carefully manipulated into the duodenum via the papilla (Fig. 2). Caution is necessary to prevent guidewire damage or fracture with a sharp needle tip. The puncture needle and EUS scope are removed, leaving the guidewire in place (Fig. 3). The duodenoscope is reinserted along the guidewire. Recannulation is attempted using the guidewire exiting the papilla, employing either an along-the-wire or over-the-wire cannulation technique (Fig. 4). Upon successful biliary deep cannulation, the originally planned procedure for biliary diseases can be performed. One important consideration before completing the procedure is the bile duct being punctured with an FNA needle during EUS-RV. This could lead to bile leakage if the internal pressure of the biliary system is not managed. To minimize this risk, especially if there are any potential risks for increased internal biliary pressure, performing biliary drainage using naso-biliary drainage or biliary stent might be advisable. If EUS-RV is unsuccessful after a biliary puncture, the transition to HGS (if the approach is from the stomach) or percutaneous transhepatic biliary drainage (PTBD) should be considered.

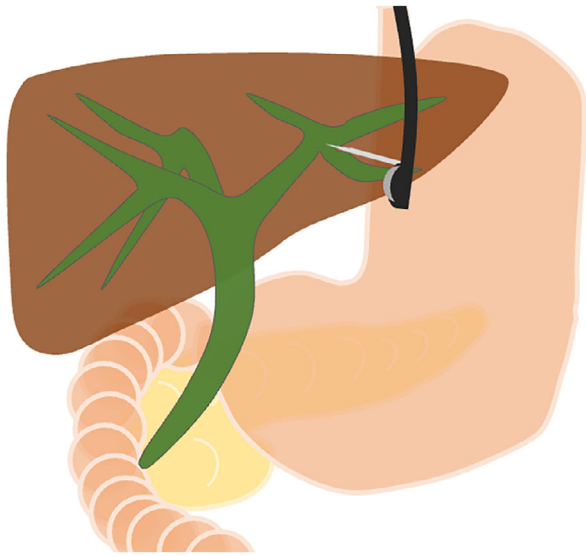


Figure 1 The bile duct is punctured under endoscopic ultrasound guidance.

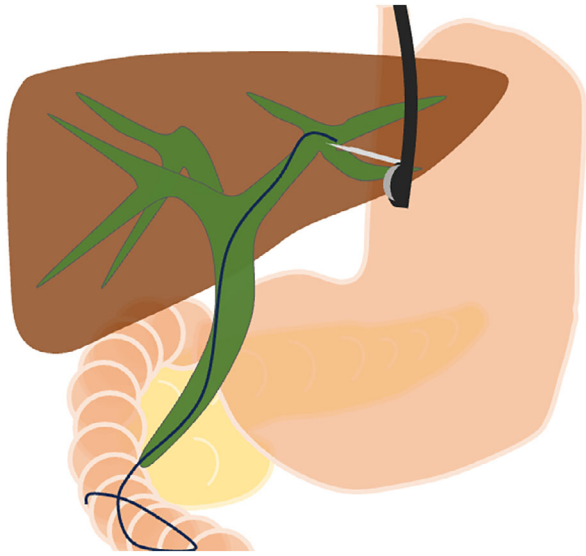


Figure 2 A guidewire is placed into the duodenum via the needle, bile duct, and the papilla.

TECHNICAL TIPS FOR BILIARY ACCESS

BILIARY ACCESS, FROM biliary puncture to guidewire placement, represents the most challenging step in

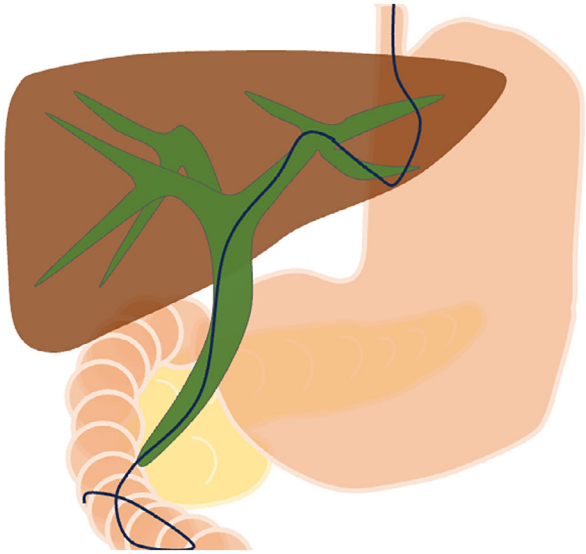


Figure 3 The puncture needle and endoscopic ultrasound scope are removed, leaving the guidewire in place.

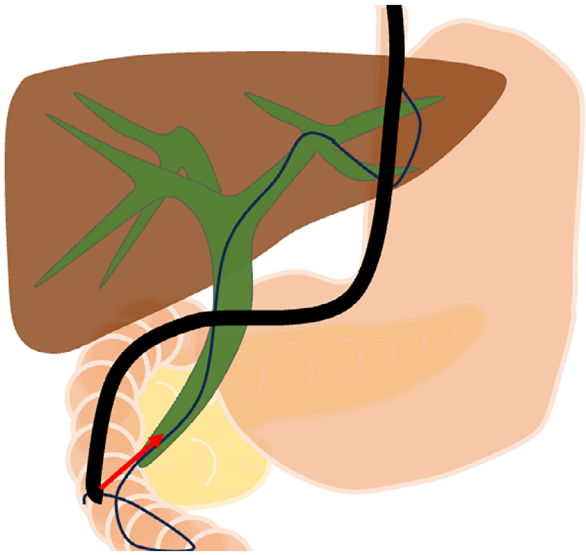


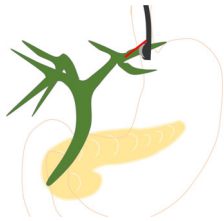
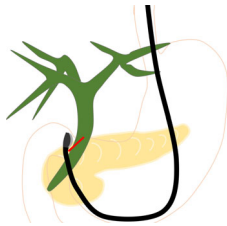
Figure 4 A duodenoscope is again inserted into the duodenum and recannulation is made with the help of the guidewire placed under endoscopic ultrasound guidance.

EUS-RV. This difficulty arises from the need to manipulate a guidewire through the papilla and into the duodenum through a sharp FNA needle lacking catheter support within the biliary system. Therefore, meticulous attention to both EUS scope position and puncture site selection is crucial for successful guidewire placement. Three fundamental combinations of EUS scope position and bile duct puncture site can be employed during EUS-RV: stomach-intrahepatic bile duct (IHBD), D1-extrahepatic bile duct (EHBD), and D2-EHBD. The stomach-IHBD approach offers a stable scope position and facilitates maintaining needle direction towards the papilla rather than the periphery. However, the extended distance between the puncture site and the papilla can hinder guidewire placement due to limitations in pushability and torqueability. Conversely, the D1-EHBD approach provides a stable scope position with a shorter distance to the papilla. However, the puncture needle tends to deviate towards the hilum, compromising guidewire placement towards the papilla. The D2-EHBD approach presents the most favorable condition for guidewire maneuverability due to the very short distance to the papilla and the needle trajectory aligning with the ampulla. This facilitates maintaining good control of the guidewire during its advancement towards the papilla. However, achieving D2 puncture necessitates withdrawing the EUS scope in the duodenum during needle puncture, potentially leading to dislodgement from the duodenum and into the stomach, resulting in an unstable scope position (Table 1).[30] A prospective pilot study evaluated an algorithm for EUS scope position and bile duct puncture site selection during EUS-RV. This algorithm prioritized the D2-EHBD approach, followed by stomach-IHBD or D1-EHBD if D2 puncture proved not feasible.[21] The study achieved a 100% success rate (10/10) in patients undergoing D2-EHBD puncture, compared to 66.7% (6/9) with alternative approaches, although the difference was not statistically significant. Adverse event rates were also comparable, with 10% (1/10) in the D2-EHBD group and 22.2% (2/9) in the others. In our institution, D2-EHBD is the preferred approach for EUS scope position and bile duct puncture during EUS-RV. However, anatomical variations and biliary disease can sometimes impede D2 puncture. In such cases, the stomach-IHBD approach becomes the alternative, provided the troubleshooting techniques outlined below are feasible.

TECHNICAL TIPS FOR RECANNULATION

IN THE RECANNULATION for the bile duct using the guidewire placed in the duodenum via the papilla by EUS-RV, there are two cannulation methods: the along-the-wire method, in which the bile duct is cannulated along the guidewire, and the over-the-wire method, in which the guidewire is grasped and withdrawn through the biopsy channel and a cannula is inserted over the withdrawn

Table 1 Comparison of scope position and punctured site of the biliary duct

Scope position	Stomach	D1	D2
Punctured site	IHBD	EHBD	EHBD
Schema			
Direction of the needle	Ampulla	Hepatic hilar	Ampulla
Distance to the papilla	Long	Short	Very short

D1, the duodenal bulb; D2, the second portion of the duodenum; EHBD, extrahepatic bile duct; IHBD, intrahepatic bile duct.

Table 2 Features of recannulation method

	Along the wire	Over the wire
Pros	• Simple procedure • Possibility to reduce the procedure time	• Assured cannulation if the guidewire could be pulled out
Cons	• Technically difficult	• Complicated procedure • Possibility to lose the guidewire during the retrieval

guidewire to obtain bile duct intubation (Table 2).[31] In the along-the-wire method, the guidewire is used as a landmark for bile duct cannulation, so there is less risk of losing the guidewire, such as unintentional guidewire return into the bile duct, and the procedure is simpler. The guidewire placed under EUS guidance is not required to be retrieved, which may allow bile duct intubation to be achieved in a short time. On the other hand, cannulation along the placed guidewire can be technically difficult. In the over-the-wire method, cannulation is relatively easy if the placed guidewire can be pulled out through the biopsy channel. However, the procedure is complicated and time-consuming because the soft part of the guidewire must be grasped and pulled out through the biopsy channel and there is a risk of guidewire loss during the guidewire retrieval. No comparative studies have been reported on these methods of recannulation, and the choice of the recannulation method should be based on an understanding of the advantages and disadvantages of each method. Even with the along-the-wire method, cannulation is often difficult because the displaced location of the ampulla by the guidewire hinders a clear view of the ampulla. In our institution, therefore, the over-the-wire method is the primary method. In the past, the soft part of the guidewire was grasped with a snare or biopsy forceps, but recently a loop cutter (FS-410; Olympus, Tokyo, Japan; Fig. 5) has been used to grasp the border between the hard and soft parts of the guidewire and to pull it out through the biopsy channel. It is important to know the structure of the guidewire being used in advance, because if the soft part is grasped, the inner core is too thin and the guidewire is easily disrupted during withdrawal, while if the rigid part is grasped, it is too rigid and cannot be pulled into the scope. If the guidewire is disrupted during withdrawal, the guidewire is fixed at the tip of the scope by using the elevator, and the duodenoscope is removed with the guidewire. The duodenal scope is then again inserted over the guidewire for bile duct cannulation. As an ingenious extension of the over-the-wire method, a slit can be made at the catheter tip and placed over the guidewire. This enables bile duct cannulation along the guidewire without guidewire withdrawal. This technique,

Figure 5 A loop cutter (FS-410; Olympus, Tokyo, Japan).

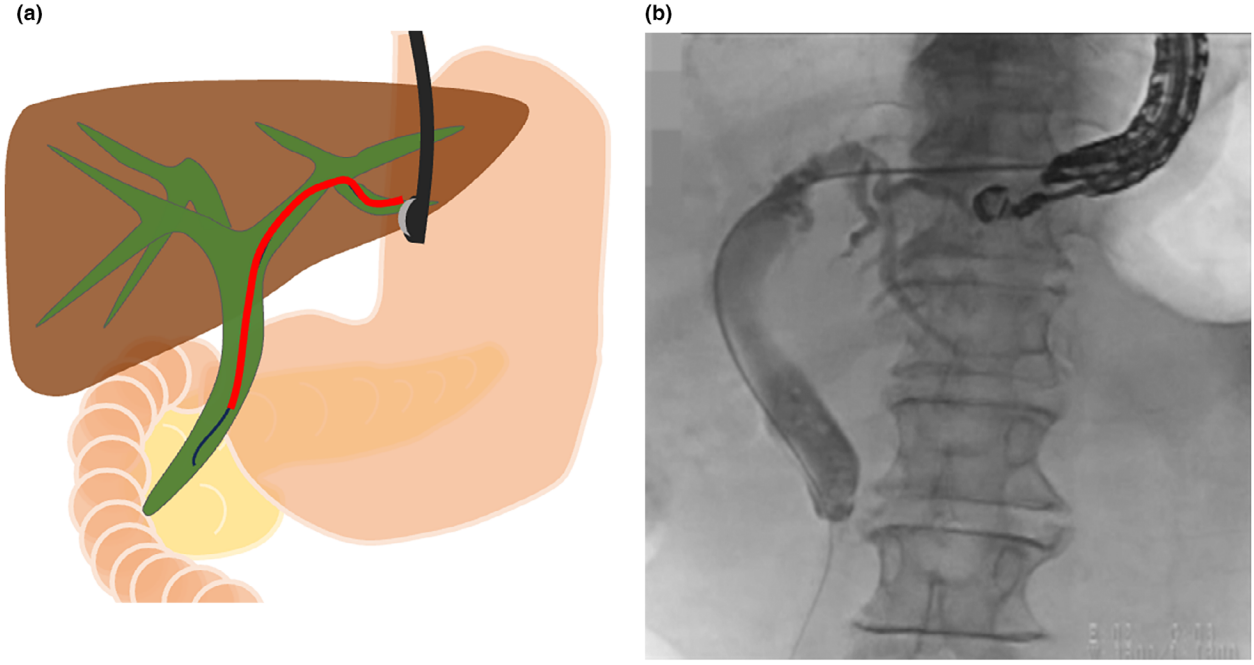


Figure 6 (a) A dilator is inserted into the biliary system to support guidewire manipulation. (b) A fluoro image showing the inserted dilator into the biliary system for the hybrid rendezvous technique.

known as "hitch-and-ride," may prove to be an effective method.[23]

TROUBLESHOOTING: NEEDLE PUNCTURE

EUS-RV TYPICALLY UTILIZES a 19G FNA needle, enabling the use of guidewires up to 0.035 inch. Despite the large bore, the inherent rigidity of the needle can hinder elevator function and limit the EUS scope angle range. The larger caliber may also make it difficult to puncture undilated bile ducts. These characteristics can pose challenges when attempting to puncture the bile duct, while avoiding vessels or puncturing an insufficiently dilated bile duct. In these cases, a smaller and less rigid 22G needle might offer advantages for bile duct puncture due to its improved maneuverability and punctureability.[32] However, a 22G needle limits guidewire selection up to 0.018 inch. Martinez *et al.*[25] conducted a retrospective study assessing EUS-RV using a 22G needle and 0.018 inch guidewire combination. Their EUS-RV success rate in bile ducts was 81.5% (22/27). Conversely, in all five failed cases, the reason for failure was the inability to place the guidewire into the duodenum through the ampulla. The reduced maneuverability and pushability of 0.018 inch guidewires, compared to 0.025 inch guidewires, could cause difficulty in the guidewire placement.

TROUBLESHOOTING: GUIDEWIRE PLACEMENT

IF THE BILE duct is successfully punctured and guidewire placement is attempted, but the guidewire does not traverse the papilla, the hybrid rendezvous (HRV) method could be useful in the stomach-IHBD approach. If the guidewire cannot pass the papillary or bile duct obstruction, it is left in place. The puncture needle is removed, and a 6Fr dilator with the connecting hub removed (PD-SS6F180C; Gadelius Medical, Tokyo, Japan) or other tapered ERCP catheters with the injection port cut is inserted into the bile duct (Fig. 6). Insertion of the dilator into the biliary system supports guidewire manipulation, similar to a guiding catheter in a percutaneous approach. This improved maneuverability and pushability facilitate guidewire placement through the biliary obstruction, across the papilla, and into the duodenum. The EUS scope is then removed (Fig. 7) and replaced with a duodenal scope, leaving the guidewire and dilator in place. Biliary cannulation proceeds as in standard EUS-RV, but the placed guidewire can be further manipulated using the inserted dilator, aiding in secure guidewire capture. The puncture site is also sealed by the dilator, potentially minimizing bile leakage during the procedure. A retrospective study evaluating EUS-HRV reported its application in eight patients experiencing difficulty with guidewire placement through the papilla

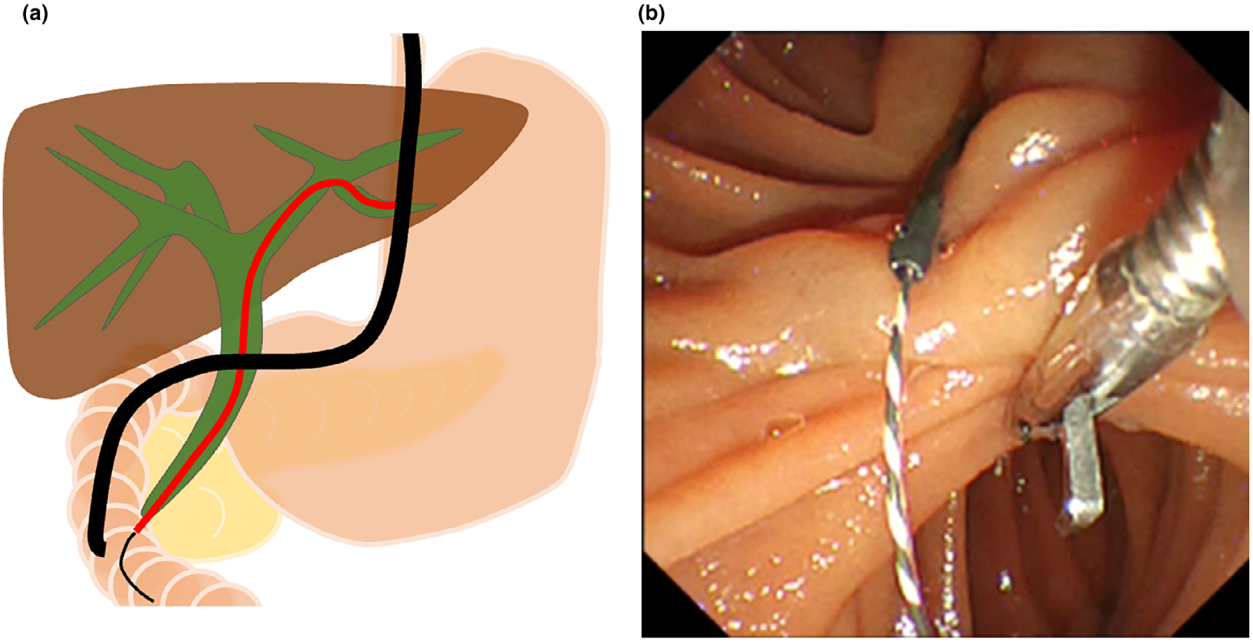


Figure 7 (a) The dilator was in place during recannulation to support retrieval of the guidewire. (b) An endoscopy image showing the guidewire coming out through the dilator during hybrid rendezvous technique.

(out of 14 patients who underwent EUS-RV with the stomach-IHBD approach).[33] In all patients, the guidewire was successfully advanced into the duodenum, and biliary cannulation was achieved. As for safety, mild pancreatitis occurred in one patient. HRV may be an effective salvage method when guidewire placement proves difficult using the stomach-IHBD approach. EUS-HRV could apply to the combination of a 22G needle and a 0.018 inch guidewire using a 3Fr microcatheter.[34] Other techniques to salvage difficult guidewire placement include using an access needle with a flexed tip and rotation function.[35] This needle can change the needle's direction even in the D1-EHBD approach and could be useful in EUS-RV to change the needle direction towards the ampulla side with that approach route. If guidewire placement remains unsuccessful despite these efforts, consider transitioning to alternative EUS-BD techniques like CDS and HGS as salvage options, based on the specific biliary disease being treated.

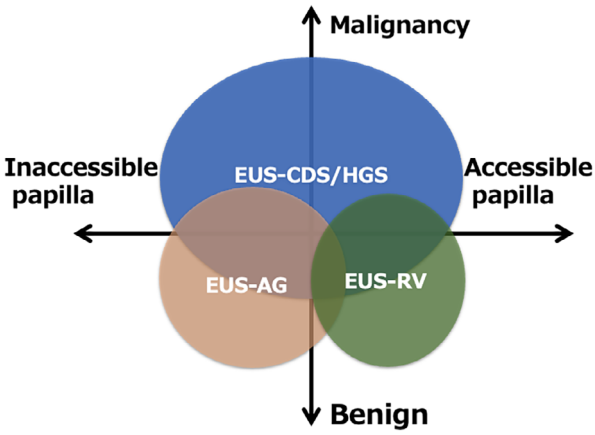


Figure 8 Indications of each endoscopic ultrasound-guided (EUS) biliary drainage technique. AG, antegrade treatment; CDS, choledocoduodenostomy; HGS, hepatico-gastrostomy; RV, rendezvous technique.

INDICATION OF EUS-RV

CLINICALLY, EUS-RV COULD be indicated during ERCP for biliary diseases if selective biliary cannulation proves difficult. However, before deciding on indication of EUS-RV, careful consideration of the patient's condition, endoscopist's skill level, and facility resources is necessary. If the procedure is not urgent, repeat ERCP as a different session can be an option and is reported as having relatively high success rates.[36] While bleeding tendency should not be a concern as the patient has undergone ERCP, it is crucial to reconfirm the absence of bleeding tendencies since EUS-RV involves EUS-guided bile duct puncture. The endoscopist

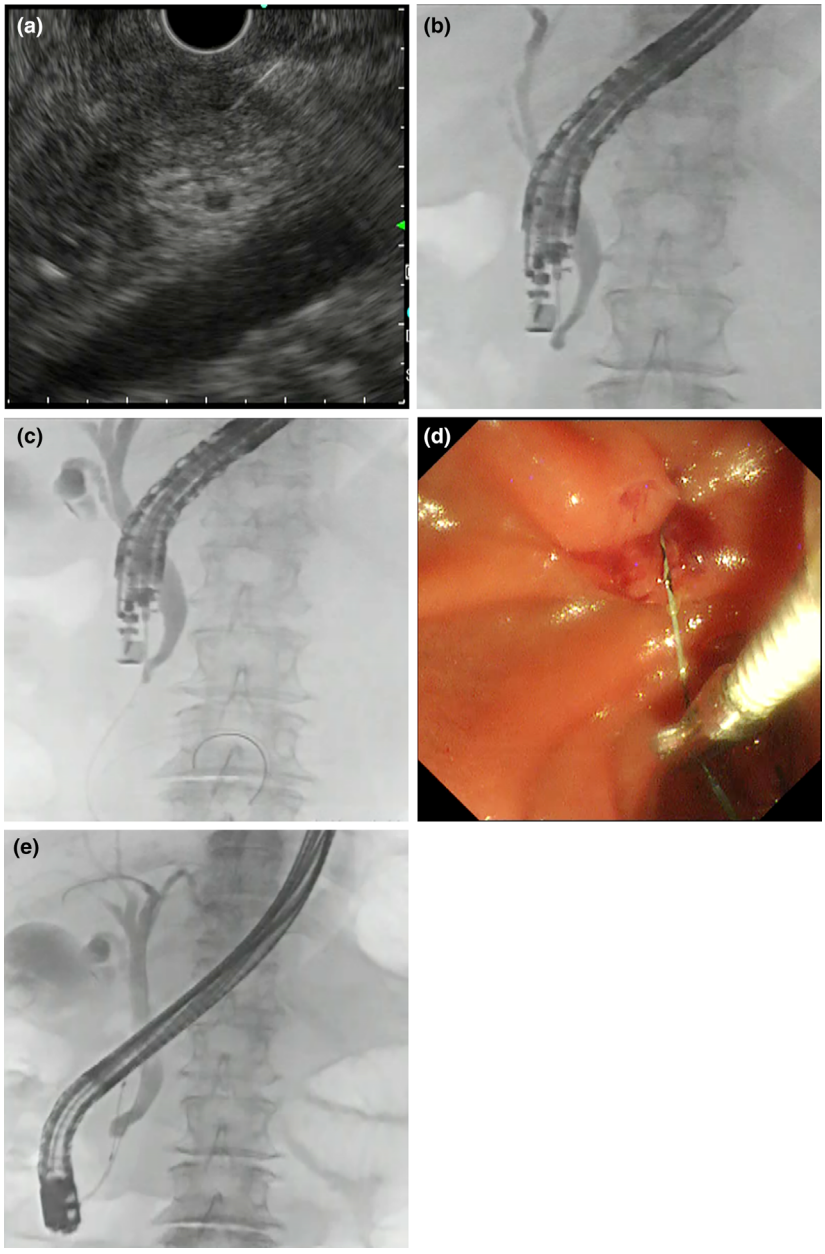


Figure 9 (a) A common bile duct measuring 2 mm in diameter was punctured from the second portion of the duodenum using a 19G needle. (b) A contrast media is injected into the biliary duct to confirm proper puncture. (c) A guidewire was placed into the duodenum through the needle, bile duct, and ampulla. (d) The guidewire was grasped with a loop cutter between the soft and hard parts. (e) Biliary deep cannulation was achieved using a double-lumen catheter with the over-the-wire method.

must be proficient in both the EUS- and ERCP-related procedures. Additionally, backup options like PTBD or surgery should be available in case of unsuccessful EUS-RV. If these factors are deemed acceptable, EUS-RV could be considered. However, as EUS-BD encompasses various procedures with overlapping indications, it is essential to determine the most appropriate approach based on the specific biliary disease indicated for ERCP (Fig. 8). EUS-CDS/HGS is primarily employed as a drainage method for malignant diseases,[37] EUS-AG is mainly indicated

for patients with inaccessible ampulla,[38] and EUS-RV is predominantly utilized in cases of benign diseases with accessible ampulla. In the management of benign biliary diseases such as biliary stone or biliary stricture, treatment of the diseases itself as well as biliary drainage is required, so an ERCP-based treatment, which can utilize the physiological route and can provide a wider range of treatment options with more available devices and techniques, is considered preferable. However, there are no established guidelines for the use of EUS-BD techniques. The decision to use EUS-RV should be made with careful consideration of these overlapping indications.

CASE OF EUS-RV

ERCP WAS PERFORMED for the management of common bile duct stones. Selective biliary cannulation failed due to technical limitations. Following careful consideration, we opted for EUS-RV as a salvage procedure for the difficult biliary cannulation. We exchanged the standard scope for an EUS scope and punctured the EHBD from D2 with confirmation by contrast injection (Fig. 9a,b). A guidewire was inserted into the duodenum through the needle, traversing the common bile duct and ampulla (Fig. 9c). The EUS scope was replaced with the duodenoscope. The guidewire exiting the papilla was grasped with a loop cutter and pulled through the scope channel (Fig. 9d). A double-lumen catheter was inserted over the guidewire into the bile duct, followed by the placement of a second guidewire within the bile duct (Fig. 9e). Deep biliary cannulation was achieved, enabling successful endoscopic sphincterotomy, stone removal, and device withdrawal to complete the procedure.

CONCLUSION

THIS REVIEW ARTICLE outlines the clinical outcomes and technical aspects of EUS-RV, including technical tips and troubleshooting. In cases of failed EUS-RV, alternative management strategies are also crucial. While EUS-RV is a useful salvage technique for unsuccessful bile duct cannulation, it is essential to consider potential difficulties during the procedure and have appropriate management plans to ensure safety.

CONFLICT OF INTEREST

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NONE.

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