

EUS-guided biliary drainage

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BACKGROUND

In patients with native upper GI anatomy, selective biliary cannulation by expert endoscopists is successful in more than 90% of procedures. When bile duct access cannot be obtained as a result of failed cannulation, altered anatomy, ampullary distortion or diverticulum, gastric outlet obstruction (GOO), or in situ duodenal stents, EUS-guided biliary drainage (EUS-BD) is increasingly used as an alternative to interventional radiology or surgery.

Wiersema et al,¹ in 1996, were the first to report the use of EUS-guided cholangiography in 7 patients who underwent successful EUS-guided cholangiography after failed ERCP. In 2001, Giovannini et al² reported the first experience with EUS-guided choledochoduodenostomy (CDS) placing a plastic stent in a patient with unresectable pancreatic cancer. Mallery et al,³ in 2004, introduced the EUS-guided rendezvous (RV) approach, and subsequently multiple investigators have reported a variety of technical alternatives and outcomes of EUS-BD.⁴⁻¹⁵

EUS-BD is performed by using 1 of 3 basic approaches that include the RV technique, transluminal (TL) stenting,^{16,17} and EUS-guided antegrade transpapillary (or trans-anastomotic) biliary stent placement.^{18,19}

RV TECHNIQUE

A linear echoendoscope is used to obtain biliary access ideally within a dilated segment of the bile duct proximal to the site of obstruction. The tip of the echoendoscope is positioned within the gastric fundus or duodenal bulb to access the intrahepatic and extrahepatic bile duct, respectively. A 19- or 22-gauge FNA needle is used to puncture the bile

Abbreviations: CDS, choledochoduodenostomy; EUS-BD, EUS-guided biliary drainage; GOO, gastric outlet obstruction; HGS, hepatogastrostomy; PTBD, percutaneous transhepatic biliary drainage; RV, rendezvous; SEMS, self-expandable metal stent; TL, transluminal.

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duct, and then access is confirmed with EUS or with contrast injection and fluoroscopic confirmation. Generally speaking, a 19-gauge needle is usually preferable because it allows passage of larger guidewires and rapid infusion of contrast. A 0.035-, 0.025-, 0.021-, or 0.018-inch guidewire is advanced into the bile duct. When initially selecting a smaller caliber 0.021- or 0.018-inch guidewire, many opt to exchange it for a larger-caliber guidewire to facilitate subsequent tract dilation and stent placement. Use of smaller guidewires (eg, 0.025 inch instead of 0.035 inch) may decrease the risk of guidewire shearing because it allows for more space between the guidewire and the needle tip. The trajectory of the echoendoscope and needle is angled to facilitate antegrade guidewire passage through the obstructed segment and across the papilla to coil in the guidewire in the small bowel. When an ideal echoendoscope or needle trajectory cannot be achieved, the guidewire tends to inadvertently pass into the proximal rather than distal biliary tree. When this occurs, one may intentionally advance the guidewire into the proximal bile duct, which sometimes allows looping and subsequent transpapillary guidewire advancement. Once the guidewire is properly placed, the echoendoscope is removed, and a standard duodenoscope is inserted to retrieve the guidewire by using a biopsy cable or snare, thereby allowing standard endoscopic retrograde cholangiography and stent placement (over-the-wire technique).²⁰ Alternatively, one may cannulate along the RV guidewire (Fig. 1). Stent selection should be dictated by patient and procedural factors.

DIRECT TL TECHNIQUE

The TL approach is performed by using only the echoendoscope. After achieving bile duct access as described previously, the puncture tract is dilated by using either a dilating catheter or balloon. Various devices may then be used to facilitate antegrade stent placement,^{21,22} with selection based on the patient's anatomy and features of the obstructing pathology. The TL approach most commonly entails creation of choledochoduodenostomy or hepatogastrostomy.

Choledochoduodenostomy

The CDS technique requires creation of a neofistula between the duodenum and extrahepatic bile duct. The extrahepatic bile duct is identified from the duodenal

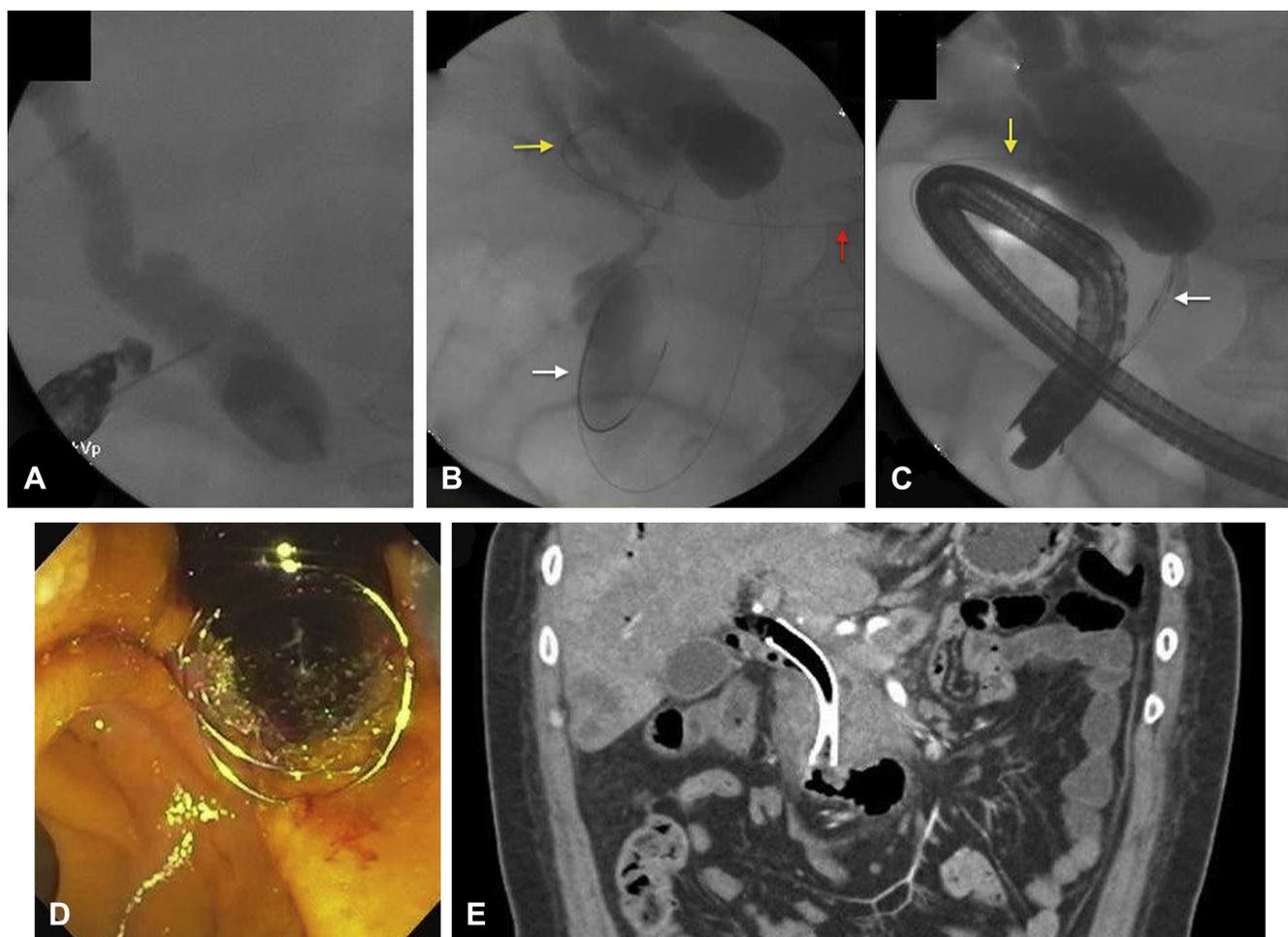


Figure 1. EUS-guided biliary drainage by using the rendezvous technique. **A**, The common bile duct (CBD) was punctured with a 19-gauge needle under endosonographic guidance, and antegrade cholangiography revealed dilated CBD with distal obstruction. **B**, Antegrade passage of the guidewire can be seen passing via the stomach (*red arrow*), duodenal bulb (*yellow arrow*), and through the papilla and coiled in the distal duodenum (*white arrow*). **C**, The wire was grasped through a duodenoscope, and a sphincterotome was passed over the guidewire (*white arrow*). The guidewire was withdrawn from the duodenal bulb (*yellow arrow*) and re-advanced in a retrograde fashion to facilitate transpapillary stent placement. **D**, Dark bile flowing through transpapillary self-expandable metal biliary stent. **E**, Coronal CT showing self-expandable metal stent placed across distal biliary stricture due to a pancreatic mass.

bulb by using the long echoendoscope position, which provides a stable echoendoscope and ideal access to the bile duct. It is important to select a trajectory and angle of biliary access that promotes guidewire advancement toward the hepatic confluence. After initial cholangiography and guidewire placement (Fig. 2), tract dilation can be achieved by using a needle-knife, cystotome, or bougie. The degree of dilation should be sufficient to allow stent insertion while avoiding excess dilation that risks biliary leak and stent migration. Placement of a fully covered self-expandable metal stent (SEMS) is favored over plastic stents to minimize the risk of migration as well as bile leak.

Hepatogastrostomy

The success of hepatogastrostomy (HGS) largely depends on identification of a dilated left hepatic duct within

segment 2 or 3 of the liver as viewed from the gastric cardia or body. The presence of a large hiatal hernia sometimes mandates needle puncture from more distal aspects of the stomach. Bile duct access puncture, tract dilation, and stent placement are performed in similar fashion to CDS. A key measure to account for both metal stent foreshortening and movement of the stomach away from the liver during respiration during HGS is the need to leave more than 3 cm of the SEMS in the gastric lumen (Fig. 3). As for CDS, most favor the use of SEMS in preference to plastic stents when the diameter of the accessed intrahepatic duct allows. Placement of a partially covered stent may aid in avoiding obstruction of secondary ducts and may decrease the risk of stent migration.

Ideal indications for the HGS include the presence of a proximal biliary stricture and/or after distal gastrectomy that prohibits access to the extrahepatic bile duct.⁵

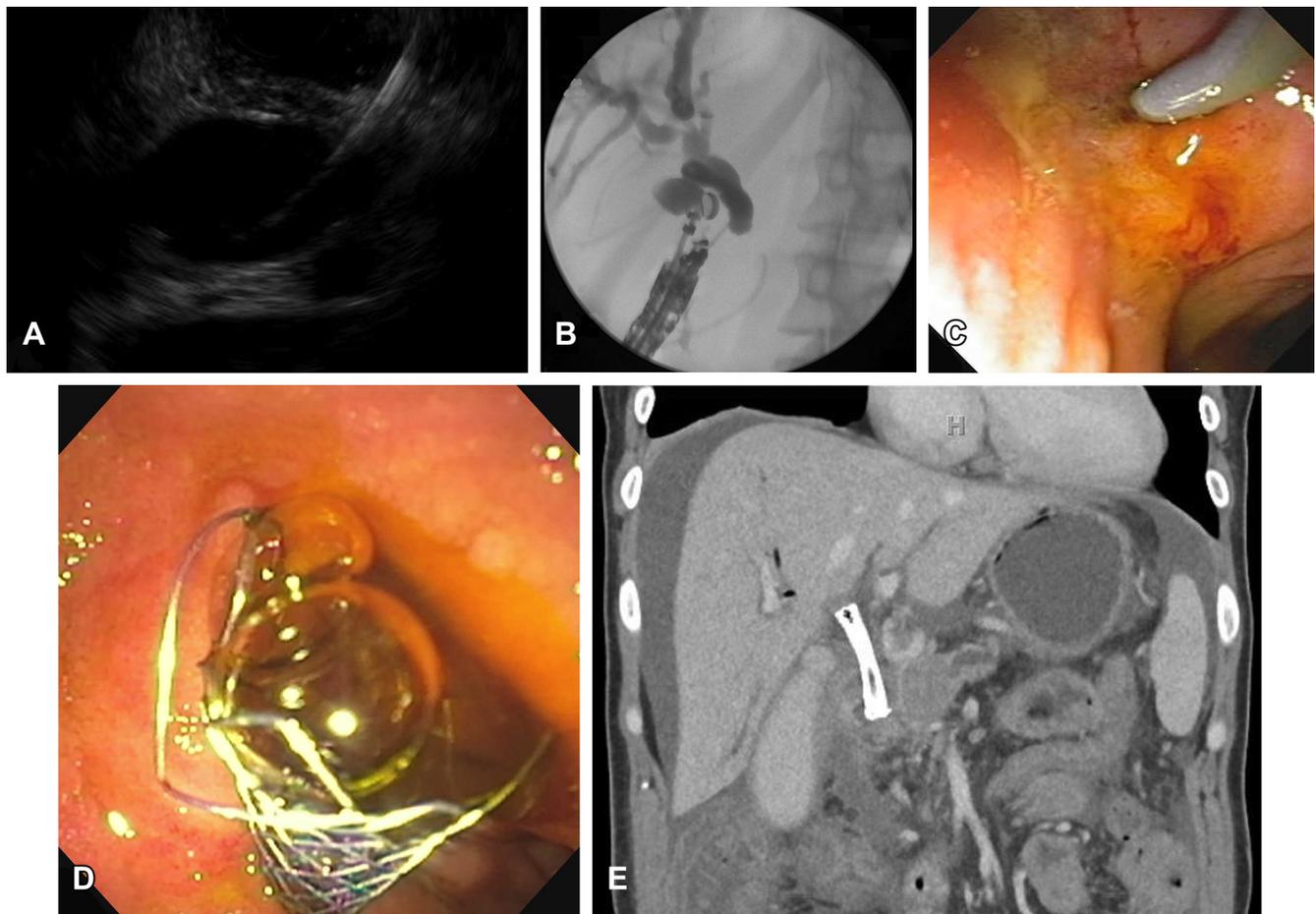


Figure 2. EUS-guided choledochoduodenostomy. **A**, Endosonographic image demonstrating the needle and guidewire within the common bile duct (CBD). **B**, Antegrade cholangiography demonstrating intra- and extrahepatic biliary dilation with an abrupt cutoff in the mid-CBD. A prophylactic pancreatic stent placed at a failed ERCP remains in situ. **C**, The choledochoduodenostomy (CDS) was dilated with a dilating bougie catheter (4F-7F). **D**, Large volume of bile flowing through the fully covered self-expanding metal biliary stent that was placed across the CDS. **E**, Coronal CT 4 weeks after EUS-guided biliary drainage reveals the optimal stent position and the absence of biliary ductal dilation.

ANTEGRADE STENTING

The initial steps for FNA biliary access, cholangiography, guidewire placement, and tract dilation are analogous to the aforementioned approaches. However, with the antegrade stenting technique, anterograde stent placement is performed by advancing the stent through the echoendoscope over the guidewire to traverse the stricture and then the papilla (ie, transpapillary) or anastomosis (transanastomotic) (Fig. 4).^{21,22} The type of stent should be dictated by patient and procedural factors.

OUTCOMES OF EUS-BD

Data mostly from small retrospective series suggest that EUS-BD can be performed with high therapeutic success (87%) but is associated with a 10% to 20% risk of adverse events, most of which are mild to moderate in nature. Serious adverse events are rare but may occur.²³ Artifon et al²⁴ recently reported the first prospective,

randomized study that compared EUS-BD with percutaneous transhepatic biliary drainage (PTBD) in 25 patients (13 EUS-CDS and 12 PTBD) with malignant biliary obstruction after failed ERCP. All procedures were technically and clinically successful in both groups, and the adverse event rate was similar for both approaches ($P = .44$): EUS-CDS (15.3%) and PTBD (25%). Cost was also similar in both groups. These data suggest that EUS-BD may provide an acceptable alternative to PTBD; however, large prospective studies are needed to verify their findings and to more clearly define the role, ideal patient cohort, and risks associated with both techniques.

Shah et al¹⁵ reported their experience performing EUS-BD in the setting of surgically altered anatomy or failed ERCP. Of the 70 patients who underwent attempted EUS-BD, a cholangiogram could be obtained in 68 patients (97%) with 66 patients having cholangiographic findings indicating the need for therapeutic intervention. EUS-BD by using the RV technique was successful in 37 of 50 patients (74%). In the remaining 16 patients, direct EUS-guided interventions (HGS, CDS, and antegrade stenting)

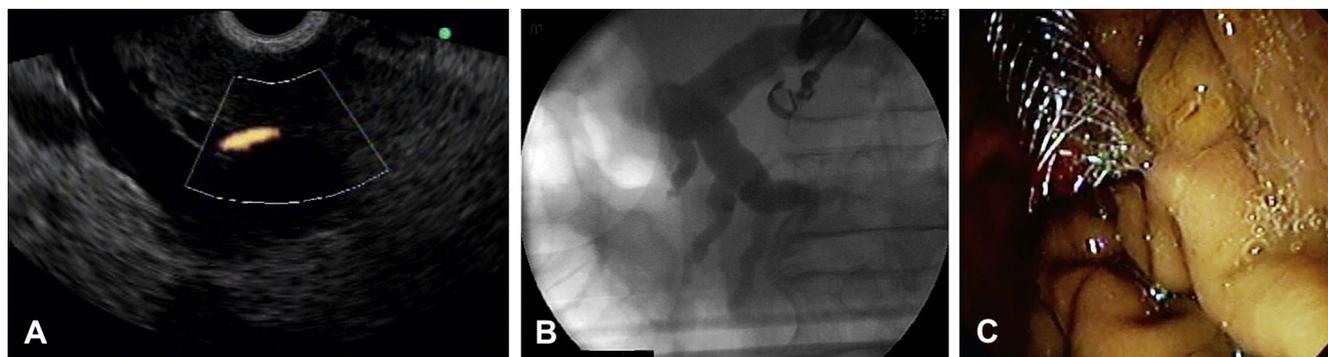


Figure 3. EUS-guided hepatogastrostomy. **A**, EUS image demonstrating a dilated left intrahepatic duct (segment III) and Doppler mode showing a vessel close to the biliary duct. **B**, Radiologic image demonstrating biliary access with a 19-gauge needle and a dilated biliary tree on antegrade cholangiography. **C**, Endoscopic image showing a deployed self-expandable metal stent in the proximal stomach.

were successful in 13 patients (81%). Six adverse events occurred, most of which were managed conservatively.

Recently, Park et al²⁵ reported their experience using EUS-BD by 1 endoscopist in 45 patients with either benign or malignant biliary obstruction at a tertiary center in South Korea. These authors previously reported a high adverse event rate (20%)⁹ for EUS-BD and aimed to determine whether a modified technique of “enhanced guidewire manipulation” could improve the procedural safety and efficacy. The modified approach included (1) optimizing the angle of bile duct access, (2) use of smaller-caliber guidewires to avoid shearing, (3) use of a 4F catheter to help direct the guidewire toward/through distal stricture/ampulla, and (4) preferential puncturing of a segment 2 intrahepatic duct to promote guidewire passage toward the hilum.²⁵ In this study, the 45 patients underwent same-session EUS-BD after failed ERCP, and technical success was achieved in 41 patients (91%). Functional success, defined by a decrease in cholestatic indices to less than 75% of pretreatment values within 1 month of the procedure, was achieved in 39 patients (95%). A total of 5 adverse events (11%) developed in 4 patients, including 1 each of pancreatitis, focal bile peritonitis, limited pneumoperitoneum, intraperitoneal stent migration, and biloma. In accordance with the American Society for Gastrointestinal Endoscopy lexicon’s severity grading system, mild and moderate adverse events developed in 3 and 1 patients, respectively.²⁶

To evaluate the primary study aim of Park et al²⁵ of whether advanced guidewire manipulation might decrease the adverse event rate to less than 20% ($n = 11$) as in their previous study that included 55 patients who underwent either EUS-CDS or EUS-HGS,⁹ it is important to evaluate potential reasons for adverse events in the 11 patients (graded as mild in 7 and moderate in 4). Interestingly, 9 of the 11 patients in whom an adverse event developed underwent fistula dilation by using a needle-knife, which was independently associated with the occurrence of adverse events (odds ratio 12.4, $P = .01$). In the more recent trial, fistula dilation with a needle-knife

was used in only 5 patients. This finding may indicate the need to avoid needle-knife cautery for tract creation/dilation during EUS-BD. Our preference is to avoid both overly aggressive tract dilation and the use of noncoaxial electrocautery for tract dilation (ie, dilation with a needle-knife) whenever possible.

Gupta et al²⁷ reported their long-term outcomes of a multicenter study using EUS-BD in 246 patients, by using an intrahepatic approach in 60%. Successful biliary drainage rates were similar for both the extrahepatic and intrahepatic approaches (84.3% vs 90.4%, respectively; $P = .15$). A higher clinical success rate was noted in malignant diseases compared with benign diseases (90.2% vs 77.3%, $P = .02$). Adverse events included pneumoperitoneum (5%), bleeding (11%), bile leak/peritonitis (10%), and cholangitis (5%) with similar rates reported regardless of approach or disease pathology.

When considering the data, it is important to note that nearly all published studies originate from tertiary high-volume centers that employ highly qualified interventional endoscopists. We believe that these procedures should ideally be performed by endoscopists well trained in both ERCP and EUS and carried out at institutions where surgery and radiology backup are available to help manage failed interventions and/or adverse events.

RV versus direct transluminal techniques

Although the RV technique is favored by many endoscopists because it avoids the creation of a permanent bilioenteric fistula and the need for fistulous tract dilation, which may result in bleeding, pneumoperitoneum, and pneumomediastinum, there are few data to determine how RV and TL techniques compare in terms of efficacy and safety. Khashab et al²⁰ compared both approaches in 35 patients who underwent EUS-BD (RV, 13; TL, 20) for malignant distal biliary obstruction and failed ERCP. Technical and clinical success was achieved in 33 of 35 patients (94%) and 32 of 33 patients (97.0%), respectively. The mean postprocedure bilirubin level was 1.38 mg/dL in the RV group and 1.33 mg/dL in the TL group ($P = .88$),

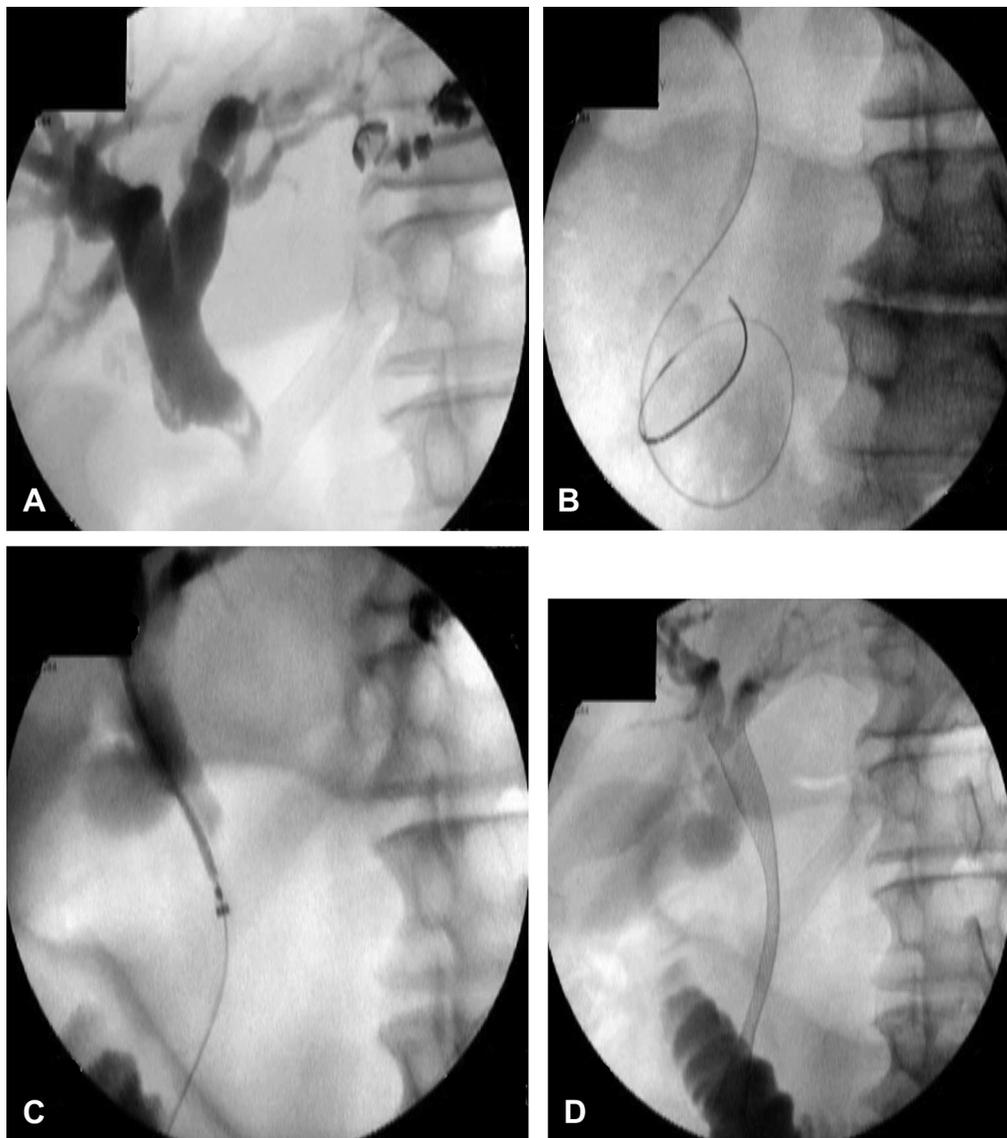


Figure 4. EUS-guided antegrade stenting. **A**, A left intrahepatic duct was punctured, and antegrade cholangiography revealed a long distal biliary stricture with proximal dilation of the biliary tree. **B**, A 0.025-inch guidewire was advanced through the stricture and coiled in the duodenum. **C**, A self-expandable metal stent was advanced antegradely over the guidewire. **D**, A stent was deployed with 1 end in the duodenum and the other end above the biliary stricture.

and the duration of hospitalization was also similar for both groups ($P = .23$). Their adverse event rate was comparable for the RV and TL groups (15.4% vs 10%, $P = .64$). Long-term outcomes were similar between both groups with stent migration ($n = 1$) in the RV group at 62 days and stent occlusion ($n = 1$) in the TL group at 42 days post-EUS-BD. Their data suggest that both RV and TL techniques are equally effective and safe.

There are at least 4 potential disadvantages to EUS-guided biliary rendezvous that merit discussion. First, successful completion of the rendezvous approach is reported in only 75% of patients, even among expert endoscopists often due to GOO or surgically altered anatomy.^{15,25} A second shortcoming is the need to exchange the echoendoscope for a duodenoscope, during which time there is

the tendency for guidewire displacement. A third limitation is prolonged procedure times that result from (1) the need to manipulate the guidewire through the site of obstruction and ampulla, (2) the need to exchange the echoendoscope for a duodenoscope, and (3) subsequent retrograde biliary interventions. A final shortcoming of RV EUS-BD is the risk of acute pancreatitis because of manipulation of the papilla.^{6,11,15}

Our experience suggests that TL stenting is a safe alternative to RV EUS-BD when biliary drainage is successfully achieved,^{12,13,28} but there is the risk of a bile leak if the biliary obstruction cannot be lessened. The use of several techniques may facilitate successful and safe TL stent placement. First, the TL tract should not be dilated until a satisfactory guidewire position has been achieved. Second, the

tract should be dilated only to a diameter to allow stent insertion while avoiding aggressive dilation that risks a biliary leak.¹² Third, cautery-assisted tract dilation should be avoided if possible to minimize the risk of adverse events, particularly bleeding and bile leak. Fourth, fully covered metal stents should be used to minimize the risk of stent migration and bile leakage. Finally, carbon dioxide insufflation should be used to help reduce the risk of pneumoperitoneum. We agree with those who favor RV EUS-BD, but believe that a TL approach is an effective and safe alternative, provided the described safeguards are adopted.

CDS VERSUS HGS TECHNIQUES

Artifon et al²⁹ recently reported a randomized trial comparing the outcomes of EUS-CDS and EUS-HGS in 49 patients with unresectable distal malignant biliary obstruction after ERCP. The technical success rate was 91% for CDS and 96% for HGS ($P = .61$). Similarly, clinical success was comparable in both groups (77% vs 91%, respectively; $P = .23$). The mean procedural time (48.4 vs 47.8 minutes, $P = .84$), and the postprocedure mean quality-of-life scores were also similar. The overall adverse event rate was 16.3% (CDS, 12.5%; HGS, 20%). The authors concluded that CDS and HGS techniques provide similar efficacy and safety and both are valid options for draining distal malignant biliary obstruction after failed ERCP.

INTRAHEPATIC VERSUS EXTRAHEPATIC ACCESS ROUTES FOR EUS-BD

The RV and TL techniques are both amenable to either an intrahepatic or an extrahepatic approach in patients with native anatomy. However, the optimal access route has not been established for either technique. In cases of RV EUS-BD, Dhir et al³⁰ found that the extrahepatic transduodenal approach was associated with significantly shorter procedure times and less postprocedure pain, bile leak, and subdiaphragmatic air. They also found a trend toward higher success rates with extrahepatic RV (93% vs 50%).²⁵ Similarly, limited data suggest that direct TL EUS-BD via an extrahepatic route (CDS) may be safer than the intrahepatic route (HGS).⁹ Therefore, many prefer extrahepatic access whether performing RV or direct TL EUS-BD.

Dhir et al³¹ evaluated clinical success and adverse event rates in 68 patients undergoing EUS-BD by using a variety of techniques. The overall success rate was 95.6% and was similar regardless of the technique. Adverse events were reported in 14 patients (20.6%), with death occurring in 4 patients (4.4%). The adverse event rate was significantly higher for the intrahepatic access versus extrahepatic (transduodenal) route (30.5% vs 9.3%, $P = .03$). There was no significant difference in adverse event rates among TL and

transpapillary approaches or direct versus RV techniques. Based on logistic regression analysis, transhepatic access was the only independent risk factor for adverse events ($P = .03$). As a result of the analogous technical and clinical success of EUS-BD regardless of access route, stent insertion direction, or drainage route and the association of intrahepatic access with adverse events, the authors recommended the extrahepatic (transduodenal) route for EUS-BD with RV stent placement whenever possible.

Causal factors for the increased risk of intrahepatic access have not been definitely established, but likely relate to multiple reasons. First, the intrahepatic route necessitates that the needle traverse the peritoneal cavity, which risks pneumoperitoneum and peritoneal bile leakage. Second, the stomach and liver move independently (eg, during respiration and peristalsis), which may induce stent migration, biloma formation, and increased trauma to the bilioenteric tract (which increases the risk of postprocedure pain and bile leak). Finally, smaller-caliber intrahepatic ducts may not accommodate wider 8- to 10-mm metal stents, which can theoretically predispose to pneumoperitoneum and bile leakage due to incomplete sealing of the bilioenteric fistula. Extrahepatic access, on the other hand, has many potential advantages including the close proximity of the duodenum to the dilated bile duct and a relatively fixed bile duct with minimal respiratory influence. Further prospective studies comparing the safety of these different techniques are needed.

EUS-BD IN PATIENTS WITH PRE-EXISTING DUODENAL STENTS

ERCP in patients with GOO is challenging, especially in the presence of a duodenal SEMS. Although ERCP can be accomplished by fenestration of the stent in certain cases, other approaches for biliary access and drainage are needed when the papilla cannot be reached or visualized.¹² Khashab et al¹² performed EUS-BD in 9 patients with pre-existing duodenal SEMSs and an inaccessible ampulla. The bile duct was accessed via either a transgastric ($n = 3$) or transduodenal ($n = 6$) approach, requiring needle passage through the interstices of the duodenal stent in 5 patients. Biliary access was accomplished via an extrahepatic ($n = 7$) or an intrahepatic approach ($n = 2$). After guidewire passage and tract dilation, fully covered or uncovered SEMSs were placed. Antegrade stent insertion (direct TL access) was required in 2 patients due to failed efforts to advance the guidewire antegrade through the obstruction and to the duodenum, thereby prohibiting transpapillary drainage. Jaundice resolved in all patients, and no significant adverse events were reported. Mild pancreatitis and cholecystitis developed in 1 patient after placement of a fully covered transpapillary SEMS.¹²

Hamada et al³² compared the safety and efficacy of EUS-BD ($n = 7$) and ERCP-directed transpapillary drainage

($n = 13$) in patients with an indwelling duodenal SEMs. EUS-BD was performed via HGS by using an SEMs in 3 patients and via CDS by using an SEMs or a plastic stent in 2 patients each. Transpapillary drainage was performed by using an SEMs in all patients. The stent patency rate in the EUS-BD group was higher than that in the transpapillary drainage group at 1 month (100% vs 71%) and 3 months (83% vs 29%). The EUS-BD group had a nonsignificantly lower rate of stent dysfunction compared with the transpapillary group (14% vs 54%, $P = .16$). The adverse event rate was similar between the groups ($P = 1.00$), with moderate bleeding in 1 patient in the EUS-BD group and mild pancreatitis in 1 patient in the transpapillary group. The authors concluded that EUS-BD is a viable alternative to transpapillary drainage in the presence of an indwelling duodenal SEMs. We favor EUS-BD over ERCP in patients with duodenal stents due to the potential for improved stent patency, especially when considering the challenges of retrograde cannulation in these patients.³³

EUS-BD WITH HEPATODUODENOSTOMY

The presence of an isolated right intrahepatic ductal obstruction is largely viewed as a contraindication to EUS-BD. Park et al³⁴ evaluated the feasibility and safety of EUS-guided hepatoduodenostomy in patients with isolated right intrahepatic ductal obstruction. EUS-cholangiography of the right intrahepatic ductal was successful in 6 patients, with antegrade stenting achieved in 2 patients, antegrade transanastomotic stenting in 1 patient, antegrade transanastomotic balloon dilation in 1 patient, and cholangiography alone as a roadmap in 1 patient. The procedure was unsuccessful in 1 patient because of failed guidewire manipulation. The technical success rate of EUS-guided hepatoduodenostomy–assisted cholangiography and biliary decompression was 100% (6 of 6) and 83% (5 of 6), respectively. There were no procedure-related adverse events. Additional studies are needed to verify these promising preliminary findings.

EUS-BD versus PTBD

Data directly comparing EUS-BD with PTBD are limited, leaving uncertainty about how best to manage patients after failed ERCP. There has been only 1 small randomized, controlled trial that included 25 patients with malignant biliary obstruction and failed ERCP with similar outcomes reported in both arms (see previously).²⁴

More recently, Khashab et al³⁵ retrospectively compared the outcomes of 73 patients who underwent either EUS-BD ($n = 22$) or PTBD ($n = 51$). Although the technical success rate was higher for PTBD (100% vs 86.4%, $P = .007$), the clinical success rate was similar (92.2% vs 86.4%, $P = .40$). PTBD was associated with a higher risk of adverse events (index procedure: 39.2% vs 18.2%; all procedures including reinterventions: 80.4% vs 15.7%),

but the stent patency and survival were similar for both groups. The total cost was more than 2 times higher for the PTBD procedure ($P = .004$), mainly the result of the significantly greater need for reintervention (80.4% vs 15.7%, $P = .001$). The authors concluded that EUS-BD and PTBD appear to provide comparable efficacy, but EUS-BD may offer more safety at a significantly lower cost due to the need for fewer reinterventions.

A potential advantage of EUS-BD is the ability to access various sites of the biliary system,³¹ thereby allowing drainage even in the setting of duodenal obstruction or duodenal bypass surgeries. EUS-BD may also be performed in patients with ascites and liver metastasis that may be difficult when using percutaneous approaches. In addition, the avoidance of percutaneous catheters eliminates the associated skin irritation, leakage, and pain that are particularly troublesome to patients. Moreover, EUS-BD can be performed during the same endoscopy session after failed ERCP, which avoids the need for repeated interventions and allows for timely biliary drainage and initiation or resumption of chemoradiation if needed.^{15,25} Additional study is needed to evaluate these theoretical advantages of EUS-BD.

Hara et al³⁶ performed a prospective study of EUS-CDS for primary therapy of malignant biliary obstruction (ie, not after failed ERCP) in 17 patients. Both technical and clinical success was achieved in 94% of patients. However, we believe that, based on published data and personal experience, currently EUS-BD should be reserved as a rescue technique.

WHEN TO PERFORM EUS-BD?

We recommend obtaining informed consent from all patients for possible EUS-BD at the time of ERCP, in particular those at high risk of failed biliary cannulation (eg, surgical anatomy, previous failed ERCP, periampullary cancer with duodenal invasion on imaging, duodenal stent covering the ampulla). This consent process mandates a thorough discussion regarding the potential indications, benefits, and risks after possible failed cannulation and available alternatives such as repeat ERCP versus percutaneous or surgical drainage. It also requires that the endoscopist ensures adequate time, skilled staff, and appropriate backup in the event of failed EUS-BD and/or resulting adverse event. Nevertheless, consenting for EUS-BD at the time of ERCP precludes the need for repeated endoscopic interventions and allows for timely biliary drainage.

CURRENT LIMITATIONS AND RECENT ADVANCES

The growth in acceptance and performance of EUS-BD has been slowed, not only by the relative lack of well-

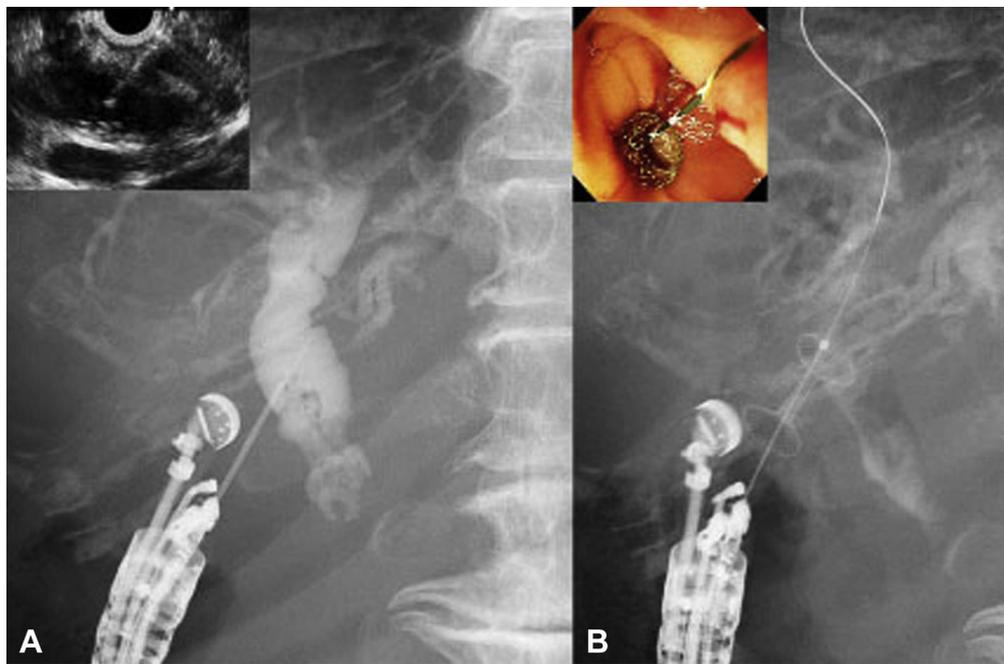


Figure 5. EUS-guided choledochoduodenostomy by using a lumen-apposing stent. The extrahepatic bile duct was punctured with a 19-gauge needle by using a transduodenal approach (*upper left corner*). Cholangiography showed the stricture in the distal bile duct (**A**). After tract dilation, an 8-mm AXIOS stent was placed in the extrahepatic bile duct (**B**, fluoroscopic imaging; *upper left corner*, endoscopic imaging).

designed studies and data, but also by the limitations in echoendoscope design. Current echoendoscopes have an elongated and relatively wide diameter tip that may preclude traversal of luminal stenosis. Also, once guidewire access is obtained, the echoendoscope design limits adequate endoscopic visualization that makes stent deployment and other endotherapy challenging. A forward-view echoendoscope has been developed that may overcome this technical challenge. This new device has a blunt tip, similar to a standard gastroscope, and preliminary data for performing interventions appear promising.³⁷ However, use of the forward-viewing echoendoscope has been limited, with many endosonographers unsure as to its role or greater utility.

Another hindrance to the progress of therapeutic EUS in general is the absence of dedicated and procedure/technology-specific accessories. Currently, most EUS-guided interventions are being performed by using ERCP accessories, some of which are not conducive for use with a curvilinear echoendoscope. A novel lumen-apposing metal stent (Axios; Xlumena, Mountain View, Calif) was recently developed and has been successfully tested in experimental³⁸ and clinical^{39,40} settings. The Axios is a fully covered, saddle-shaped, 6 to 8 mm in diameter nitinol stent with bilateral anchor flanges for CDS (Fig. 5). The design helps appose tissues, thereby minimizing the risk of leak and promoting fistula formation between nonadherent extraintestinal fluid collections or the bile duct and the GI lumen. Preliminary data for this novel stent design for gallbladder drainage are promising,^{39,40} and our limited personal experience also suggests its safe use for extrahepatic bile duct drainage. Its use for drainage of intrahepatic biliary

ducts may be relatively contraindicated at this time due to its short length and wide diameter.

CONCLUSION

Existing data suggest that EUS-BD is a safe and effective procedure to provide biliary access and drainage after failed ERCP whether it is performed via a RV or direct TL technique. An extrahepatic access route may be preferable for distal biliary obstruction and appears to be associated with a decreased incidence of adverse events. EUS-BD provides a viable alternative to PTBD, and limited available data suggest equivalent efficacy and safety. Indications and methods for EUS-BD are yet to be standardized; thus, the approach should be individualized for each patient based on the endoscopist's experience and the patient's anatomy. Further prospective, multicenter, controlled studies are needed to further delineate appropriate indications, predictors of success and adverse events, optimal approach, and clinical outcomes compared with other drainage procedures.

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