Review Article

Can endoscopic ultrasound help to drain the gallbladder?

Jun-Ho Choi, Do Hyun Park,* Sang Soo Lee, Dong-Wan Seo, Sung Koo Lee, Myung-Hwan Kim

A B S T R A C T

Percutaneous transhepatic gallbladder drainage (PTGBD) is a less invasive standard procedure to decompress the inflamed gallbladder in patients who are at high risk for emergency cholecystectomy. Recently, endoscopic ultrasonography-guided transmural gallbladder drainage (EUS-GBD) has been proposed as an alternative effective treatment modality for the management of acute cholecystitis in high-risk patients. EUS-GBD includes EUS-guided naso-gallbladder drainage, gallbladder aspiration, and gallbladder stenting via a transmural endoscopic approach. Several investigators have reported high technical success with acceptable complication rates. Further prospective evaluation of the feasibility, safety, and efficacy of EUS-GBD will help identify the most suitable indications for this procedure. This article is a detailed review of the use of EUS for gallbladder drainage, with an emphasis on its technical aspects.

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Introduction

Although laparoscopic cholecystectomy is the treatment of choice for patients with acute cholecystitis, this procedure is unsuitable for patients of advanced age or with advanced malignancy or underlying comorbidity.1–5 Currently, nonsurgical gallbladder drainage is performed through percutaneous and endoscopic drainage procedures. Percutaneous transhepatic gallbladder drainage (PTGBD) has been considered the preferred method for several decades in patients with high surgical risk, with clinical response rates of 78–100%.6–11 Despite its usefulness, the percutaneous drainage procedure has several drawbacks, including a postprocedural adverse event rate of 0.3–12%.6–10,12 PTGBD may be contraindicated in patients with massive ascites or severe coagulopathy. In addition, percutaneous drainage catheters cause patient discomfort, and are related to inadvertent catheter removal or migration. Endoscopic gallbladder drainage includes transpapillary gallbladder drainage with nasobiliary drainage (ENGBD), transpapillary gallbladder stenting, or endoscopic ultrasound (EUS)-guided transmural gallbladder drainage (EUS-GBD).13–20 Endoscopic transpapillary gallbladder drainage is subject to low technical success rates due to nonvisualization of the cystic duct on the cholangiogram or failure of guide wire cannulation through the cystic duct into the gallbladder.14,16,18,21 In this circumstance, EUS-GBD is gaining favor as an effective alternative approach for the management of acute cholecystitis in high-risk patients (Table 1).22–27 The potential benefits of EUS-GBD are that it is a one-stage procedure after the transpapillary approach and avoids long-term external drainage in cases in which external drainage catheters cannot be internalized. This article describes the indications, techniques, and outcomes of published data on EUS-GBD.

Indications for EUS-GBD

EUS-GBD can be considered if patients are not thought to be candidates for cholecystectomy because of their underlying comorbidity, poor surgical performance (American Society of Anesthesiologists Physical Status Classification System score of IV or V), or advanced malignancy after an unsuccessful transpapillary cystic approach. For patients who have previously undergone unsuccessful endoscopic retrograde cholangiopancreatography (ERCP) via a transpapillary cystic approach, EUS-GBD can be considered. To avoid complications, it is also important to select patients with adequate adherence between the inflamed gallbladder wall and the adjacent gut wall under the EUS window. Transmural gallbladder drainage has several potential advantages over the transpapillary approach, including avoidance of ERCP-related pancreatitis. The transmural approach is not limited by the shape of the cystic duct or inaccessible papilla.

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Procedure of EUS-GBD

There are various approaches and different types of devices with different effects on drainage. We describe in detail our preferred technique using a conventional therapeutic linear endoscope (Fig. 1).

The gallbladder is usually visualized from the prepyloric antrum of the stomach or duodenal bulb using a linear-array echoendoscope (GF-UCT240-AL; Olympus Optical Co., Ltd., Tokyo, Japan) with fluoroscopic guidance. The puncture point usually corresponds to the gallbladder neck or body. A 19-gauge needle (EUSN-19-T; Cook Endoscopy, Winston–Salem, NC, USA) is inserted into the gallbladder under EUS guidance, after confirming the absence of intervening vessels. Bile is aspirated, and contrast medium is then injected to obtain a cholecystogram. A 0.035 inch guidewire (Jagwire; Microvasive Endoscopy, Boston Scientific, Watertown, MA, USA) with fluoroscopic guidance. The puncture point usually corresponds to the gallbladder neck or body. A 19-gauge needle (EUSN-19-T; Cook Endoscopy, Winston–Salem, NC, USA) is inserted into the gallbladder under EUS guidance, after confirming the absence of intervening vessels. Bile is aspirated, and contrast medium is then injected to obtain a cholecystogram. A 0.035 inch guidewire (Jagwire; Microvasive Endoscopy, Boston Scientific, Watertown, MA, USA) is passed through the needle and coiled in the gallbladder. After removal of the EUS needle, a 6F or 7F bougie (Soehendra Biliary Dilatation Catheter; Cook Endoscopy) is inserted to dilate the fistula tract. If there is resistance to the advancement of the bougie catheter, a triple-lumen needle-knife (Microtome; Boston Scientific Corp., Natick, MA, USA) is passed through the needle and coiled in the gallbladder. After removal of the EUS needle, a 6F or 7F bougie (Soehendra Biliary Dilatation Catheter; Cook Endoscopy) is inserted to dilate the fistula tract. If there is resistance to the advancement of the bougie catheter, a triple-lumen needle-knife (Microtome; Boston Scientific Corp.) with a 7F shaft diameter is minimally used to dilate the tract by applying a brief burst of pure cutting current. During this procedure, it is important not to separate the tip of the echoendoscope from the gastric/duodenal wall because otherwise access may be accidentally lost. Next, a 5F nasobiliary drainage tube (ENBD-5; Cook Endoscopy) and/or covered self-expandable metal stent (CSEMS; BONA-AL stent; Standard Sci Tech Inc., Seoul, Korea; 10 mm in diameter and 4–7 cm in length) is placed over the guidewire. If there are thick pus and small particles of lithiasis, it may be necessary to place an additional nasobiliary catheter through the stent lumen for continuous irrigation. The size of the stent is decided by approximating the distance between the gallbladder and the gut wall with extra length based on EUS. Antibiotics are permitted prior to the procedures.

EUS-guided transmural nasobiliary gallbladder drainage

In cholecystitis with thick content, placing a nasobiliary catheter into the gallbladder can be useful for repeat rinsing. Generally, a 5F nasobiliary catheter for gallbladder drainage is preferred, thus obviating the need for a large fistulous tract, which is the main risk factor for bile leakage. A nasobiliary drainage tube is less likely to be dislodged than a PTGBD tube. Follow-up cholecystography through the nasobiliary tube can be performed to evaluate the patency of the cystic duct and whether there has been any leakage at the puncture site (Fig. 2).

EUS-guided transmural gallbladder stenting

A 7–8.5F double pigtail plastic stent or CSEMS is placed in the gallbladder. Metal stents have advantages over plastic stents when used in EUS–GBD. First, metal stents can seal the gap between the stent and the fistula tract by expanding, thereby reducing the risk of bile leakage. Second, metal stents have been designed to avoid the risk of migration and biliary leakage by enlarging the flares at the end of the stent 90° (BONA-AL stent) or by means of bilateral anchor flanges to ensure lumen-to-lumen apposition (AXIOS; Xlumena Inc., Mountain View, CA, USA). Third, metal stents are larger in diameter than plastic stents. Thus, metal stents may facilitate draining of thick or necrotic debris in the acutely inflamed gallbladder. Fourth, metal stents can be reconfigured if the outer sheath of the delivery device is not fully deployed. This may allow the endoscopist to adjust the position of the stent, thereby avoiding unnecessary repuncture.

EUS-guided gallbladder aspiration

EUS-guided gallbladder aspiration (EUS-GBA) is a simple procedure that does not require the placement of a nasobiliary catheter or stent. EUS-GBA can be carried out repeatedly if the first attempt is unsuccessful. EUS-GBA can be performed without severe complications, because smaller EUS needles are used to minimize leakage at the puncture site. Despite its potential advantages, EUS-GBA has not been widely performed, because acute cholecystitis with thick content requires continued drainage. However, if placement of a drainage tube is not possible, single and repetitive EUS-GBA can be considered as alternative treatment modalities for patients with acute, high-risk cholecystitis who cannot undergo emergency cholecystectomy. However, a further prospective study is warranted to confirm this idea.

Technical considerations of EUS-GBD

Although standardized techniques and devices for EUS-GBD have not yet been established, there are several technical tips to remember for a successful procedure. First, the position of the echoendoscope and selection of the puncture site are important. From the anatomical point of view, it has been suggested that punctures directed toward the neck of the gallbladder are preferable, because this portion is fixed at the gallbladder bed in the liver and connected to the extrahepatic bile duct by the cystic duct. Lee et al. have suggested that punctures into the body of the gallbladder are effective when a nasobiliary drainage tube is used. Song et al. have reported that it may be reasonable to use a transduodenal approach toward the neck of the gallbladder with a double-pigtail stent. If the body of the decompressed gallbladder moves away from the gastric wall, stent migration may occur when a double-pigtail stent is used. When a catheter is accessed from the duodenal bulb, because of the angulation of the echoendoscope, the needle-knife points

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**Table 1** Summary of Previous Reports on Endoscopic-ultrasound-guided Transmural Gallbladder Drainage

<table>
<thead>
<tr>
<th>Author (y)</th>
<th>Type of study</th>
<th>No. of cases</th>
<th>Drainage</th>
<th>Technical success</th>
<th>Functional success</th>
<th>Complication</th>
<th>Profiles of postprocedural adverse events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kwan et al (2007)</td>
<td>R</td>
<td>3</td>
<td>Double-pigtail stent/nasocystic drainage tube</td>
<td>3/3 (100)</td>
<td>3/3 (100)</td>
<td>1/3 (33.3)</td>
<td>Bile leakage</td>
</tr>
<tr>
<td>Baron et al (2007)</td>
<td>R</td>
<td>1</td>
<td>Double-pigtail stent</td>
<td>1/1 (100)</td>
<td>1/1 (100)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lee et al (2007)</td>
<td>P</td>
<td>9</td>
<td>Nasocystic drainage tube</td>
<td>9/9 (100)</td>
<td>9/9 (100)</td>
<td>1/9 (11.1)</td>
<td>Pneumoperitoneum</td>
</tr>
<tr>
<td>Song et al (2010)</td>
<td>P</td>
<td>8</td>
<td>Double-pigtail stent</td>
<td>8/8 (100)</td>
<td>8/8 (100)</td>
<td>3/8 (37.5)</td>
<td>Bile leakage, pneumoperitoneum, and stent migration in each case</td>
</tr>
<tr>
<td>Jang et al (2011)</td>
<td>P</td>
<td>15</td>
<td>Modified CSEMS</td>
<td>15/15 (100)</td>
<td>15/15 (100)</td>
<td>2/15 (13.3)</td>
<td>Pneumoperitoneum (2)</td>
</tr>
<tr>
<td>Jang et al (2012)</td>
<td>P</td>
<td>30</td>
<td>Nasocystic drainage tube</td>
<td>29/30 (96.7)</td>
<td>29/30 (96.7)</td>
<td>3/30 (6.7)</td>
<td>Pneumoperitoneum (2)</td>
</tr>
</tbody>
</table>

Data in parenthesis are presented as %. CSEMS, covered self-expandable metal stent; P, prospective; R, retrospective.
tangentially and may result in an undesirable incision and postprocedural adverse events such as pneumoperitoneum or bleeding.\textsuperscript{32,33}

The main postprocedural adverse event of EUS-GBD is bile leakage into the peritoneal space, which carries a significant risk of bile peritonitis.\textsuperscript{28} Complications such as bile leakage and pneumoperitoneum are associated with excessive fistula dilation with a needle-knife, thus, it is important to use minimal dilation with 6F dilator catheters or needle-knives as a rescue method.\textsuperscript{24,32,34,35} If the stent cannot be successfully placed into the gallbladder after fistula dilation, bile peritonitis is more likely to occur after the procedure.\textsuperscript{28} Plastic stents have the drawback of a small lumen diameter, which can limit bile drainage and may increase the risk of stent migration.\textsuperscript{24,26} By comparison, EUS-GBD with a CSEMS may reduce the risk of bile leakage, because the gap between the stent and the dilated fistulous tract can be immediately sealed by the self-expanding metal stent.\textsuperscript{22} In addition, the use of carbon dioxide for endoscopic insufflations instead of air is preferred during EUS-GBD, which helps to minimize the risk of pneumoperitoneum.\textsuperscript{36} Adequate gallbladder aspiration immediately after insertion of a nasobiliary drainage tube and frequent saline irrigation during admission could decrease the risk of bile leakage.\textsuperscript{22,23}

Concerns about EUS-GBD

Bile leakage

The main risk related to EUS-GBD is bile leakage, because there is a gap between the gallbladder wall and the fistulous tract.\textsuperscript{28} However, a recent randomized controlled trial comparing the outcomes of EUS-GBD and PTGBD has reported that there is no significant difference in the safety of the procedure.\textsuperscript{23} It has also revealed that there is no bile leakage from the puncture site after EUS-GBD.\textsuperscript{23}

Is it less successful to drain thick or necrotic debris than PTGBD?

For PTGBD, an 8.5F pigtail drainage catheter is passed transhepatically and placed in the intercostals space. A CSEMS with a 10-mm diameter has a larger diameter than the 8.5F pigtail catheter, therefore, metal stents may facilitate drainage of the thick content of the inflamed gallbladder. If there are thick pus and lithiasis, the physician can insert an additional nasobiliary drainage catheter in the stent lumen for continuous monitoring and irrigation.\textsuperscript{21}
Is EUS-GBD more traumatic than PTGBD?

EUS-GBD can be used when there are massive ascites and when patients have coagulopathy or have been taking antithrombotic agents. The procedure minimizes the risk of bleeding, because the puncture sites at the prepyloric antrum or duodenum are less vascularized than the liver as the primary puncture site for PTGBD.

Relatively deeper sedation needed than PTGBD

Although patients experience less discomfort with EUS-GBD than with PTGBD, EUS-GBD needs relatively deeper sedation than PTGBD.\(^{23}\) EUS-GBD requiring moderate to deep sedation could place a strain on patients of advanced age and those with underlying comorbidity, compared with PTGBD, which requires only local anesthesia. Thus, EUS-GBD could be inappropriate in those cases.

When to remove the stent?

Based on our experience in transmural stenting of the gallbladder, we believe that in most cases, it is not necessary to remove the stent.\(^{22,24,25}\) The development of a fistulous tract between the gallbladder and the stomach/duodenum is one of the natural ways of drainage of the gallbladder. Even in the case of stent migration, the patient is likely to have no new episodes of cholecystitis due to the formation of a permanent mature fistula. Although it is too early to draw a conclusion, we believe inserted stents will have no negative impact on the life expectancy of the patients.

Review of published data on EUS-GBD

In EUS-GBD, the technical and clinical success rate is 96.7–100%.\(^{15,22–26}\) The overall rate of postprocedural adverse events is 13.6%.\(^{15,22–26}\) Postprocedural adverse events include pneumoperitoneum, bile leakage, and stent migration.\(^{22–26}\) Recently reported comparisons between EUS-GBD and PTGBD among 59 consecutive patients with acute cholecystitis who were unsuitable for cholecystectomy showed no differences in relation to technical feasibility, efficacy, and safety.\(^{23}\) Conventional CSEMSs have a larger lumen diameter but have a high risk of stent migration and bile leakage. Modified CSEMSs have been designed to obviate these drawbacks by enlarging and bending the flared ends at a 90° angle (BONA-AL).\(^{22}\) In a previous study using CSEMSs, no patient encountered bile leakage or bile peritonitis.\(^{22}\) Recently, Itoi et al have reported successful results with a newly developed lumen-apposing metal stent (AXIOS), a fully covered, 10-mm diameter, Nitinol braided stent with bilateral anchor flanges, placed in 20 patients.\(^{30}\)

Future prospects of EUS-GBD

The advantages of EUS-GBD are the avoidance of external drainage (unlike PTGBD), and no potential risk of post-ERCP
pancreatitis or cholangitis (unlike transpapillary drainage). Based on the data in the literature and given the 100% technical success rate, some endoscopists are more likely to attempt EUS-guided gallbladder drainage in preference to transpapillary gallbladder drainage. Although EUS-guided gallbladder drainage may be a feasible therapeutic option, this procedure may have more complications, such as bile leakage or pneumoperitoneum, compared with the transpapillary approach. As there is only a small number of cases reported, EUS-GBD requires further assessment in a larger cohort of patients prior to deciding whether this procedure can be recommended as an alternative modality for the management of acute cholecystitis in high-risk patients. Based on our experience, we suggest an algorithm for therapeutic intervention in the management of acute cholecystitis (Fig. 3). Accumulation of experience and the development of dedicated endoscopic devices will elucidate its standardized technique and allow establishment of its indications. Further prospective studies would help to identify the optimal strategy of EUS-GBD.

Conflicts of interest

All contributing authors declare no conflicts of interest with regard to this paper.

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