Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Title:
Hybrid transgastric NOTES for gallbladder-preserving cholecystolithotomy: a feasible and minimally invasive approach to gallstone management

Authors:
Jian Li, Shao-Ju Guo, Jing-Chao Zhang, Cheng-Shan Xu, Xue-Fang Wang, Kai Li, Hong-Yan Wang

DOI: 10.17235/reed.2026.11242/2025
Link: PubMed (Epub ahead of print)

Please cite this article as:
Li Jian, Guo Shao-Ju, Zhang Jing-Chao, Xu Cheng-Shan, Wang Xue-Fang, Li Kai, Wang Hong-Yan. Hybrid transgastric NOTES for gallbladder-preserving cholecystolithotomy: a feasible and minimally invasive approach to gallstone management. Rev Esp Enferm Dig 2026. doi: 10.17235/reed.2026.11242/2025.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

HYBRID TRANSGASTRIC NOTES FOR GALLBLADDER-PRESERVING CHOLECYSTOLITHOTOMY: A FEASIBLE AND MINIMALLY INVASIVE APPROACH TO GALLSTONE MANAGEMENT

Study population

Total 23 patients
Demographics characteristics

Baseline characteristics	Total (n = 23)
Age, median (range), years	41 (35-61)
Sex, male, n (%)	9 (39.1)
Indication, n (%)	
Persistent or intense right epigastric pain	5 (21.7)
Recurrent right epigastric pain	18 (78.3)
WBC count, median±SD, 10^9/L	5.8±1.2
Neutrophils percentage, median±SD, %	57.6±10
Total bilirubin levels, median±SD, μmol/L	8.5±1.3
Imaging results at endoscopic transgastric GPC	
Length of the gallbladder, median (range), cm	6.5 (5.8-8.6)
Width of the gallbladder, median (range), cm	3.2 (2.6-3.9)
Length of the gallstone, median (range), cm	1.5 (1.0-1.8)
Thickness of the gallbladder, range, cm	≤0.4

Methods

All patients underwent a novel endoscopic transgastric GPC

- Technical success
- Therapeutic efficacy
- Procedure-related complications

Outcomes

The novel endoscopic transgastric GPC technique may offer a safe and effective alternative approach for performing GPC

- Technical success rate: 95.7%
- Recurrence rate: 9.1%
- Severe complications: none

Li, et al.

Revista Española de Enfermedades Digestivas (REED)
The Spanish Journal of Gastroenterology

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Hybrid transgastric NOTES for gallbladder-preserving cholecystolithotomy: a feasible and minimally invasive approach to gallstone management

Jian Li[1], Shao-Ju Guo[1], Jing-Chao Zhang[1], Cheng-Shan Xu[1], Xue-Fang Wang[1], Kai Li[1], Hong-Yan Wang[1]

[1]Department of Gastroenterology. Shenzhen Traditional Chinese Medicine Hospital, The Fourth Clinical Medical College of Guangzhou University of Chinese Medicine. Shenzhen, China

Correspondence: Hong-yan Wang. Department of Gastroenterology. Shenzhen Traditional Chinese Medicine Hospital, The Fourth Clinical Medical College of Guangzhou University of Chinese Medicine. 1 Fuhua Road, Futian District, Shenzhen 518033, Guangdong, China. **e-mail:** wanghongyan09@126.com

Authors' contributions: investigation: H. W., and J. L.; methodology: J. L., S. G., and J. Z.; supervision: K. L., C. X., and X. W.; writing-original draft: H. W., and J. L.

Conflict of interest: the authors declare no conflict of interest.

Artificial intelligence: the authors declare that they did not use artificial intelligence (AI) or any AI-assisted technologies in the elaboration of the article.

Financial support: this study was supported in part by the grant from the National Natural Science Foundation of China (No. 81703859) and the Sanming Project of Medicine in Shenzhen (No. SZZYSM202211002).

Key words: Covered lumen-apposing metal stent. EUS-guided gallbladder drainage. Symptomatic gallstone. Transgastric gallbladder-preserving cholecystolithotomy. Transgastric NOTES.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

List of abbreviations: GPC, gallbladder-preserving cholecystolithotomy; EUS, endoscopic ultrasonography; NOTES, natural orifice translumenal endoscopic surgery; CT, computed tomography; LAMS, lumen-apposing metal stent; UDCA, ursodeoxycholic acid

ABSTRACT

Background: Cholecystectomy has traditionally been the mainstay of treatment for symptomatic gallstones; however, the complications of cholecystectomy have led to the adoption of minimally invasive gallbladder-preserving approaches in some patients. A simple but highly effective technique is currently lacking. This study aimed to evaluate the feasibility and safety of a novel endoscopic transgastric gallbladder-preserving cholecystolithotomy (GPC) for this condition.

Methods: This was a single-arm prospective clinical study involving 23 patients with symptomatic gallstones enrolled between July 2018 and August 2020. All patients underwent a novel endoscopic transgastric GPC, in which we performed the cholecystogastrostomy via transgastric natural orifice translumenal endoscopic surgery (NOTES) using a gallbladder stent as the passage before advanced endoscopic cholecystolithotomy. Technical success, therapeutic efficacy, and procedure-related complications were evaluated.

Results: The technical success rate of transgastric NOTES-guided cholecystogastric stent placement was 95.7% (22/23). One case which failed due to an intraoperative finding of pericholecystic adhesions was subsequently converted to cholecystectomy. Among the 22 patients who achieved technical success, 19 underwent a simple cholecystolithotomy using a basket or balloon. In the remaining three patients, two required lithotripsy for large gallstones and the other for an incarcerated calculus using an ultraslim endoscope on retrial. All 22 patients achieved wound healing within 4 days postoperatively. Common procedure-related complications were hemorrhage and infection, all of which were mild and temporal. The overall stone recurrence rate was 9.1% at the 3-year follow-up.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Conclusion: The novel endoscopic transgastric GPC could be a safe and effective alternative endoscopic approach for GPC.

Introduction

Laparoscopic and open cholecystectomy are well-established treatments for symptomatic gallstones, with the laparoscopic approach preferred due to its minimally invasive nature and demonstrated safety and efficacy. This widespread adoption is supported by low complication rates, particularly for bile leaks (range 0.5% to 3%) and bile duct injuries (range 0.2% to 0.9%), as well as the feasibility of outpatient management in many cases (1, 2). Nevertheless, several clinical considerations must be addressed. These include potential long-term sequelae such as post-cholecystectomy digestive disorders, common bile duct stones, and sphincter of Oddi dysfunction, which are significant for certain patient subsets. Additionally, some observational studies suggest an association between cholecystectomy and increased risk of certain malignancies, particularly colorectal, pancreatic, and liver cancers in Eastern populations, though causality remains controversial and may reflect confounding factors (3-6). Consequently, minimally invasive gallbladder-preserving approaches have recently gained popularity for specific patients with cholecystolithiasis who are reluctant to undergo surgery but have a functioning gallbladder and demonstrate good tolerance towards the risk of stone recurrence, particularly young and middle-aged patients (7, 8).

Laparoscopic and choledochoscopic cholecystolithotomy has been proposed as an alternative treatment option for these conditions (9). This approach presents several advantages, including effective avoidance of the various complications associated with cholecystectomy, as well as a relatively low long-term stone recurrence rate ranging from 1% to 10% (10, 11). However, there are inherent limitations that have hindered its clinical applicability, such as the potential risks of postoperative biliary fistula and scarring. Therefore, there is an ongoing necessity to explore and develop new accessories and procedures to tackle these challenges.

Recently, novel techniques using a flexible endoscope, such as the endoscopic ultrasonography (EUS)-guided cholecystogastrostomy and transmucosal natural orifice translumenal endoscopic surgery (NOTES) method, which sought to minimize these complications, have achieved the same therapeutic effect as the laparoscopic gallbladder-preserving cholecystolithotomy (GPC) (12-14). These revolutionary therapies perform well in patients with narrow indications; nevertheless, technical challenges due to puncture or stent deployment failure and the limited intraperitoneal operating space can increase the risk of adverse events. Furthermore, the procedure-related endoclips left in the abdominal cavity during the classic NOTES procedure is also a concern for endoscopists.

To address these issues, our institution has developed a novel two-step hybrid NOTES technique. This innovative strategy integrates the merits of both EUS-guided and NOTES approaches. Specifically, we conducted the cholecystogastrostomy via transgastric NOTES, employing a gallbladder stent as the conduit preceding advanced endoscopic cholecystolithotomy. Thus, this study primarily aimed to evaluate the feasibility and safety of this novel two-step hybrid NOTES technique.

Methods

Patients

This was a single-arm prospective clinical study of patients with symptomatic gallstones confirmed on ultrasonography and abdominal computed tomography (CT) who underwent the novel endoscopic transgastric GPC from July 2018 to August 2020 at our hospital. All enrolled patients fulfilled the pre-established inclusion criteria, which consisted of having a well-functioning gallbladder (characterized by exhibiting a postprandial contraction and emptying capacity exceeding one-third of its total volume), absence of pericholecystic exudate or adhesion, and documented refusal to undergo surgical cholecystectomy (Fig. 1). The baseline characteristics of these patients are described in Table 1. Patients with peritoneal effusion, diffuse peritonitis, common bile duct obstruction, or contraindications for endoscopic interventions were excluded. Informed consent for endoscopic GPC was obtained from each patient. The

study was approved by our institutional ethics committee (No. 2018-11) and registered in the Chinese Clinical Trial Registry online (No. ChiCTR1800016608).

Instruments

A double-channel therapeutic gastroscope (EG-530D; Fujinon, Omiya, Japan), upper endoscope (EG-530WR; Fujinon), ultraslim endoscope (GIF-XP290N; Olympus Optical, Tokyo, Japan), high-frequency electrocautery (VIO300S; ERBE Elektromedizin, Tübingen, Germany), biliary electrohydraulic lithotriptor (Lithotrips-Y27080B; Karl Storz, Tuttlingen, Germany), and the frequency-doubled double-pulse neodymium:YAG (FREDDY) laser system (U100 PLUS; World of Medicine, Berlin, Germany) were used in this study. A covered lumen-apposing metal stent (LAMS) (14 mm in inner diameter, 25 mm in length; Micro tech, Nanjing, China), hook knife, extractor balloon, extractor basket (Endo Therapy; Olympus Co.), dilation balloon (Microvasive; Boston Scientific, Natick, MA, USA) and 0.035-inch hydrophilic guidewire (Loop tip; Cook Medical Co., Winston-Salem, NC, USA) were used as accessories.

Procedure

A second-generation cephalosporin was administered to prevent perioperative infections. The gastroscope was sterilized using ethylene oxide and packaged in a sterile box prior to the procedure. Each patient received oral lavage with compound chlorhexidine gargle before the procedure. After induction of standard general anesthesia, a routine gastroscopy was conducted to exclude abnormalities, and the esophagus and stomach were rinsed with sterile water to avoid peritoneal contamination.

With the assistance of a transparent cap, a mucosal incision measuring 1.5–2.0 cm was made on the anterior antrum near the small, curved side using a hook knife (Fig. 2A). The abdominal cavity was subsequently exposed using a layer-by-layer myotomy and careful gastric serosal dissection. A 0.035-inch guidewire was inserted into the working channel of the gastroscope to maintain access (Fig. 2B), and a dilatation balloon was then introduced to expand the gastric wall incision to 2.0 cm. After withdrawing the

balloon and the guidewire, a pair of endoclips (on both sides) with an endoloop were placed at the distal one-third of the incision edges. The gastroscope was advanced into the abdominal cavity across the incision, and a 9F drainage catheter was placed at the right lower quadrant under endoscopic visualization (Fig. 2C). Thereafter, the gastroscope was directed towards the upper left abdominal wall to locate the liver. Upon visualizing the visceral surface of the liver, the gallbladder was identified and grasped using foreign body forceps to allow for easy penetration of the LAMS into the gallbladder lumen (Fig. 2D). The distal stent flange was then deployed under fluoroscopic guidance, and the proximal flange was deployed under direct endoscopic visualization (Fig. 2E, F). Once deployed, stones smaller than the inner diameter of the stent were discharged spontaneously (Fig. 2F). Upon completion of the connection between the gallbladder and stomach, the aforementioned endoloop was tightened to occlude the gap between the stent and gastric incision, effectively preventing the leakage of gastric fluid into the peritoneal cavity (as shown in Fig. 3A). The patient subsequently underwent indwelling gastric tube decompression and was kept fasting for 2 days. A restricted liquid diet was commenced on the third day. The patient was monitored for a period of 4–5 days before being discharged.

Ten days later, an endoscope was advanced into the gallbladder through the cholecystogastric stent, after which cholecystolithotomy was performed. All procedures were performed under moderate sedation. A mechanical lithotriptor was used to break down the large gallstones, as described elsewhere (15, 16), and stone clearance was achieved with a basket and balloon (Fig. 3B). The stent was subsequently snared for removal as patency of the cystic duct was verified by gentle suction and lavage until the effluent through the neck of gallbladder was clear (Fig. 3C). Following confirmation of the absence of residual stones and perforation at the fistula, the endoscope was withdrawn.

After discharge, the patients received a combination of ursodeoxycholic acid (UDCA) and traditional Chinese medicine for the prevention of stone recurrence (defined as the detection of newly developed gallstones ≥3 mm in diameter within the gallbladder on imaging studies performed at least 6 months postoperatively, regardless of symptom status) for a duration of 1 year (17, 18). Additionally, each patient underwent

CT and ultrasonography 1 month postoperatively, followed by semiannual or annual surveillance for stone recurrence.

All adverse events were actively monitored with scheduled follow-ups at postoperative days 1, 3, and 7. For events occurring during the interstage hospitalization interval, surveillance relied on patient self-reporting. All procedure-related complications were systematically documented and classified according to the Clavien-Dindo grading system.

Results

The success rate of transgastric NOTES-guided cholecystogastric stent placement was 95.7% (22/23) (Table 2). Failure of stent placement occurred in one patient due to pericholecystic adhesions and our inability to pull the gallbladder close to the gastric incision after deployment of the distal stent flange into the gallbladder, resulting in the deployment of the proximal flange into the abdominal cavity rather than the gastric cavity. The procedure was ultimately converted to cholecystectomy in this patient.

Notably, of the 22 patients in whom cholecystogastric stent placement was technically successful, 19 underwent a simple cholecystolithotomy using a basket or balloon. In another two cases, lithotripsy for large gallstones was needed before removing the stones through the stent. In the remaining one case, with calculus incarcerated in the neck of the gallbladder, the endoscope could not be advanced to the desired position; however, on retrial, success was achieved after lithotripsy using an ultraslim endoscope. No instances of retained gallstones were detected in any patient during the 1-month follow-up CT and ultrasonography examinations.

The initial stent placement took an average of 80.0 ± 8.5 min. The subsequent cholecystolithotomy showed considerable interpatient variability, with a mean duration of 24.8 ± 11.2 min (range: 10–45 min). All patients maintained stable hemodynamics and oxygen saturation throughout both procedures without any interruptions related to sedation or anesthesia. In the 22 patients with stent removal, wound healing was documented in 20 cases (90.9%) using gastroscopy on the third

postoperative day; in the other two (9.1%), gastroscopy on the fourth postoperative day confirmed healing.

Common procedure-related complications were hemorrhage and infection. Two patients (8.7% [2/23]) had excessive bleeding during dissection and expansion of the gastric incision, and hemostasis was achieved using electrocoagulation. Postoperatively, 18 patients (81.8% [18/22]) exhibited an elevated white blood cell (WBC) count, with an average of 13.1×10^9/L. Among these, three patients had WBC counts exceeding 15×10^9/L, with a maximum count of 18.1×10^9/L. Additionally, three patients (13.6% [3/22]) developed fever, with a maximum temperature of 38.2°C. A few patients reported mild epigastric pain and intermittent nausea. However, these symptoms were effectively managed using symptomatic treatments such as proton pump inhibitors and mucosal protective agents. A small amount of yellowish fluid and approximately 50–150 mL of white/yellow-green contents drained from the abdominal drainage tubes and gastric tubes, respectively. No severe complications such as bile leakage or gastrointestinal perforation were observed (Table 2).

During a subsequent 3-year follow-up period, two patients (9.1% [2/22]) presented with suspected gallstone recurrence confirmed by ultrasonography (Fig. 4). One of these patients was asymptomatic, whereas the other experienced symptoms and subsequently underwent surgical cholecystectomy.

Discussion

With the rapid development of endoscopic instruments and technological innovations and the realistic needs of distinct types of patients with cholelithiasis, various endoscopic gallbladder-preserving approaches are becoming available (19, 20). Studies have examined the clinical feasibility of EUS-guided transgastric (or transduodenal) gallbladder drainage and cholecystolithiasis using LAMS. The gallbladder was first punctured through the gastric antrum (or duodenal bulb) under the guidance of EUS, and a fully covered metal stent with bilateral anchor flanges was placed. After 7–14 days, a biliary-gastric (or duodenal) fistula was formed, and an endoscope was then advanced into the gallbladder through the stent, after which cholecystolithotomy was

performed (14). In general, this staged operation for cholecystolithiasis largely overcomes the shortcomings of the traditional NOTES approach. Unfortunately, owing to its requirement for the longitudinal axis EUS equipment and the technical skills and experience that operators require to perform the endoscopic puncture procedure, its clinical use is limited to certain referral hospitals. More importantly, successful stent placement is a key technical challenge; if failure occurs, bile flows out from the incision, resulting in biliary leakage that requires an immediate surgical transfer.

As a classic illustration of endoscopic surgery, endoscopic transgastric or transrectal GPC—also known as the NOTES approach—has the advantages of simple equipment, straightforward technical requirements, and a relatively uncomplicated procedure (12, 21, 22). In this approach, the expert endoscopist performs the cholecystolithotomy merely by advancing a gastroenteroscope into the abdominal cavity via the gastric (or rectal) wall incision and finally closing the incisions of the gallbladder and gastrointestinal wall with endoclips. Nevertheless, problems such as stone migration into the peritoneal cavity, bile leakage after gallbladder dissection, and residual endoclips in the abdominal cavity remain. Simultaneously, the limited operating space of intraoperative endoscopy will itself influence not only the detection and removal of gallstones but also the closure of the gallbladder incision and other subsequent operations. This may easily lead to secondary adverse events such as abdominal infections, residual stones, failed stone removal, and biliary leakage.

To address these issues, we developed a novel two-step hybrid NOTES technique for GPC using the combined merits of the two aforementioned approaches. It not only maintains the EUS-guided method that provides a large operative space and high operative precision for cholecystolithotomy by placing the stent but also incorporates the advantageous NOTES method of puncturing the gallbladder precisely under direct vision and clamping fixation. Our approach significantly reduces the technical difficulty and enhances the success rate of stent placement, improving the potential replicability of the core procedural steps. Moreover, adverse events such as bile leakage caused by failed stent placement after gallbladder puncture could be effectively avoided. More details about our technique are provided below.

Although the stomach cavity naturally has low bacterial content due to gastric acid, infection prevention remains a crucial concern (12, 23). In the present study, the approved disinfection methods in maxillofacial surgery, stomatological surgery, and endoscopic retrograde cholangiopancreatography were used for the facial and neck skin, mouth, and gastric and esophageal lumens, respectively. Furthermore, prophylactic antibiotics were routinely administered (21, 24).

It is important to note that the therapeutic gastroscope has an outside diameter of 13 mm, requiring the gastric incision to be expanded to 20 mm to allow for the passage of the gastroscope with a transparent cap. Additionally, because the saddle section of the LAMS has a small diameter of 14 mm, the gap between the stent and the incision may cause gastric fluid leakage into the abdominal cavity. To overcome these obstacles, we designed a preset endoloop with endoclips fixed to the distal end of the incision edges, keeping it loose before advancing the gastroscope into the abdominal cavity. The stent was deployed after withdrawing the gastroscope, and the endoloop was then tightened to close the gap.

During the puncture procedure, the gallbladder is susceptible to displacement and distortion, potentially leading to stent dislodgement. This poses a technical obstacle when aiming for direct EUS-guided deployment of LAMS, despite its perceived simplicity as a one-step technique with minimal invasiveness (14, 25). To tackle this challenge, we introduced the concept of NOTES with direct visualization and advocated for the utilization of a double-channel therapeutic gastroscope. This approach offers distinct advantages in both gallbladder puncture and stent placement maneuvers. The gastroscope features a 3.8-mm work channel for managing the metal stent and a 2.7-mm channel for the use of foreign body forceps. During the procedure, the foreign body forceps is utilized to grasp and stabilize the gallbladder, ensuring successful penetration and release of the stent. In our study, all patients successfully underwent gallbladder puncture and placement of the distal mushroom head stent in a single attempt. However, despite this procedural success, the relative complexity of this hybrid NOTES technique—particularly its reliance on advanced endoscopic skills, which may not be easily reproducible by most endoscopists, including proficiency in NOTES and the use of fluoroscopic guidance—may limit its reproducibility outside of

tertiary referral centers, thus representing a technical barrier. Nevertheless, our institutional experience indicates that structured preclinical simulation training—specifically, either 10 repetitions in a porcine model or dedicated endoscopic interventional puncture simulation training conducted over a 4-week period—can achieve approximately 80% technical proficiency in this procedure.

We observed a technical success rate of 95.7%, consistent with previous reports utilizing the EUS-guided approach (14). However, in one instance, failure occurred due to the deployment of the proximal flange into the abdominal cavity. Typically, the gastric antrum's pyloric area lies adjacent to the gallbladder's inferior surface and body, both of which exhibit considerable mobility and elasticity. During deployment, the distal stent flange is intended to connect with the gallbladder, followed by deployment of the proximal flange to the gastric antrum. However, in cases of severe pericholecystic adhesion, where the gallbladder is relatively immobile, the proximal flange may fail to reach the gastric antrum and instead deploy within the abdominal cavity, resulting in procedural failure. Thus, preoperative CT scans should be carefully evaluated to assess tissue adhesions around the gallbladder, and intraoperative detection of severe adhesions warrants consideration of procedure cessation.

To expedite the procedure, we employed a dry cutting technique for gastric wall dissection, potentially heightening the risk of intraoperative bleeding. We recommend meticulous dissection and effective hemostasis, carried out by skilled surgeons, to optimize outcomes in hybrid NOTES procedures.

We achieved successful lithotomy in 22 of 23 novel procedures, without serious complications such as biliary leakage, severe bleeding, and abdominal infection. All biliary-gastric fistulae healed spontaneously within a short timeframe, and no residual stones were detected postoperatively. During the 3-year follow-up period, only two patients experienced gallstone recurrence. Importantly, this recurrence rate is significantly lower than that reported for early extracorporeal shock wave lithotripsy and gallbladder-preserving strategies from the 1980s to 1990s, which had rates of up to 50% at 5 years (26). Our preliminary trial demonstrated a reduced stone recurrence rate, likely due to stent-mediated biliary flushing that ensures complete fragment

clearance, protocolized UDCA therapy, and stringent selection of patients with preserved gallbladder contractility, thereby minimizing sludge-prone environments. Additionally, there remains a considerable risk of recurrence in patients who discontinue bile therapy or have sludge-prone bile composition. Therefore, proactive management, including lifelong annual ultrasonography and consideration of extended UDCA therapy in high-risk subgroups, is essential to sustain long-term success.

Furthermore, there are certain limitations to our study. As it is a single-arm, non-comparative design, further comparative trials are required to validate this preliminary proof-of-concept. Additionally, the restrictive inclusion criteria (e.g., excluding patients with gallbladder contractility <30%) may limit the generalizability to broader populations, such as elderly patients, those with comorbidities, or those with fibrotic gallbladders. We emphasize that this procedure is primarily intended for patients who are either unfit for surgery or adamantly refuse cholecystectomy, rather than the general gallstone population. To address these limitations, future pragmatic trials enrolling patients across the entire gallbladder function spectrum or those with complicated cholelithiasis are needed. Finally, the small sample size, primarily determined by feasibility considerations and supported by references to similar study designs, necessitates further investigation to assess the safety and long-term efficacy of the procedure (27). This includes evaluating gallstone recurrence, the impact of biliary-gastric adhesions on future cholecystectomy procedures, and other relevant outcome measures, such as the potential risk of gallbladder cancer.

In conclusion, this two-step hybrid NOTES technique provides direct visualization and overcomes the technical challenges associated with EUS-guided gallbladder puncture procedures while circumventing the drawbacks of intraperitoneal endoclips commonly observed in traditional NOTES technology. Our initial findings suggest that this technique could be a feasible non-surgical salvage option for managing symptomatic cholecystolithiasis.

Key points box

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Cholecystectomy remains the gold standard for symptomatic gallstone management; however, its associated complications have prompted the development of minimally invasive, gallbladder-preserving approaches. Currently, no widely available technique combines simplicity with high efficacy for gallbladder preservation. This study assesses the feasibility and safety of a novel endoscopic transgastric gallbladder-preserving cholecystolithotomy for symptomatic gallstones. A two-step hybrid natural orifice translumenal endoscopic surgery (NOTES) technique is proposed, providing direct visualization and overcoming the technical limitations of endoscopic ultrasonography-guided gallbladder puncture. This method also circumvents the drawbacks of intraperitoneal endoclips, commonly encountered in conventional NOTES procedures. Our findings suggest that this technique represents a promising, minimally invasive approach to gallstone management, with the potential to preserve gallbladder function. This innovation may significantly advance the adoption of gallbladder-preserving strategies in clinical practice.

Acknowledgments

We thank Chuan-bin Zheng and the rest of the medical and nursing staff in Shenzhen Traditional Chinese Medicine Hospital, The Fourth Clinical Medical College of Guangzhou University of Chinese Medicine for their support and assistance with the procedures. Also, we would like to thank Editage (www.editage.cn) for English language editing.

References

1. Mergener K, Strobel JC, Suhocki P, et al. The role of ERCP in diagnosis and management of accessory bile duct leaks after cholecystectomy. Gastrointest Endosc 1999;50:527-31. DOI: 10.1016/s0016-5107(99)70077-5.

2. Siiki A, Ahola R, Vaalavuo Y, et al. Initial management of suspected biliary injury after laparoscopic cholecystectomy. World J Gastrointest Surg 2023;15:592-9. DOI:

10.4240/wjgs.v15.i4.592.

3. Zhang Y, Liu H, Li L et al. Cholecystectomy can increase the risk of colorectal cancer: A meta-analysis of 10 cohort studies (Erratum in: PLoS One. 2018;13:e0191587). PLoS One 2017;12:e0181852. DOI: 10.1371/journal.pone.0181852.

4. Fan Y, Hu J, Feng B et al. Increased Risk of Pancreatic Cancer Related to Gallstones and Cholecystectomy: A Systematic Review and Meta-Analysis. Pancreas 2016;45:503-9. DOI: 10.1097/MPA.0000000000000502.

5. Liu Y, He Y, Li T et al. Risk of primary liver cancer associated with gallstones and cholecystectomy: a meta-analysis. PLoS One 2014;9:e109733. DOI: 10.1371/journal.pone.0109733.

6. Jung YK, Yoon J, Lee KG et al. De Novo Cancer Incidence after Cholecystectomy in Korean Population. J Clin Med 2021;10:1445. DOI: 10.3390/jcm10071445.

7. Ullah S, Yang BH, Liu D et al. Are laparoscopic cholecystectomy and natural orifice transluminal endoscopic surgery gallbladder preserving cholecystolithotomy truly comparable? A propensity matched study. World J Gastrointest Surg 2022;14:470-81. DOI: 10.4240/wjgs.v14.i5.470.

8. Qu Q, Chen W, Liu X et al. Role of gallbladder-preserving surgery in the treatment of gallstone diseases in young and middle-aged patients in China: results of a 10-year prospective study. Surgery 2020;167:283-9. DOI: 10.1016/j.surg.2019.09.001.

9. Tan YY, Zhao G, Wang D et al. A new strategy of minimally invasive surgery for cholecystolithiasis: calculi removal and gallbladder preservation. Dig Surg 2013;30:466-71. DOI: 10.1159/000357823.

10. Ye L, Liu J, Tang Y et al. Endoscopic minimal invasive cholecystolithotomy vs laparoscopic cholecystectomy in treatment of cholecystolithiasis in China: a meta-analysis. Int J Surg 2015;13:227-38. DOI: 10.1016/j.ijsu.2014.12.014.

11. Liu J, Zhu X, Zhao Q et al. A new operation for gallstones: Choledochoscopic gallbladder-preserving cholecystolithotomy, a retrospective study of 3,511 cases. Surgery 2022;172:1302-8. DOI: 10.1016/j.surg.2022.08.008.

12. Liu B, Du B, Pan Y. Video of the Month: Transrectal Gallbladder-Preserving Cholecystolithotomy via Pure Natural Orifice Transluminal Endoscopic Surgery: First Time in Humans. Am J Gastroenterol 2015;110:1655. DOI: 10.1038/ajg.2015.266.

13. Chan SM, Teoh A, Yip HC et al. Feasibility of per-oral cholecystoscopy and advanced gallbladder interventions after EUS-guided gallbladder stenting (with video). Gastrointest Endosc 2017;85:1225-32. DOI: 10.1016/j.gie.2016.10.014.

14. Guo J, Sun S. EUS-guided gallbladder drainage and gallbladder interventions in China. Endosc Ultrasound 2018;7:83-4. DOI: 10.4103/eus.eus_6_18.

15. Li J, Guo SJ, Zhang JC et al. A new hybrid anchoring balloon for direct peroral cholangioscopy using an ultraslim upper endoscope. Dig Endosc 2018;30:364-71. DOI: 10.1111/den.12989.

16. Li J, Guo SJ, Zhang JC et al. Novel peroral cholangioscopy-directed lithotripsy using an ultraslim upper endoscope for refractory Mirizzi syndrome: A case report. Medicine (Baltimore) 2020;99:e22649. DOI: 10.1097/MD.0000000000022649.

17. Lee SH, Jang DK, Yoo MW et al. Efficacy and Safety of Ursodeoxycholic Acid for the Prevention of Gallstone Formation After Gastrectomy in Patients With Gastric Cancer: The PEGASUS-D Randomized Clinical Trial. JAMA Surg 2020;155:703-11. DOI: 10.1001/jamasurg.2020.1501.

18. Li Y, Gao XX, Qin XM. Advances in research of traditional Chinese medicine for promoting bile secretion and excretion. Zhongguo Zhong Yao Za Zhi 2020;45:1287-96. DOI: 10.19540/j.cnki.cjcmm.20191112.403.

19. Wang W, Shi X, Jin Z et al. Endoscopic laser lithotripsy and lithotomy through the lumen-apposing metal stent for a giant gallstone after EUS gallbladder drainage. VideoGIE 2017;2:112-5. DOI: 10.1016/j.vgie.2017.01.015.

20. Wang W, Liu B, Qi K et al. Efficacy and safety of endoscopic laser lithotripsy and lithotomy through the lumen-apposing metal stent for giant gallbladder stones. VideoGIE 2020;5:318-23. DOI: 10.1016/j.vgie.2020.03.005.

21. Li Y, Han S. Transgastric endoscopic gallbladder polypectomy and cholecystolithiasis: A case report. Exp Ther Med 2020;19:95-8. DOI: 10.3892/etm.2019.8195.

22. Guan F, Zhang M, Wang S. Endoscopic transgastric gallbladder-preserving cholecystolithotomy for incarcerated gallbladder neck stone (with video). Gastrointest Endosc 2024;99:462-3. DOI: 10.1016/j.gie.2023.10.008.

23. Ullah S, Zhang JY, Liu D et al. Transgastric versus transrectal: Which access route is the best for NOTES gallbladder-preserving gallstone therapy. J Dig Dis 2023;24:491-6. DOI: 10.1111/1751-2980.13221.

24. Kaehler G, Schoenberg MB, Kienle P et al. Transgastric appendicectomy. Br J Surg 2013;100:911-5. DOI: 10.1002/bjs.9115.

25. Bakheet N, Ichkhanian Y, Runge TM et al. Endoscopic ultrasound-guided cholecystoduodenostomy for acute cholecystitis with removal of large (missed) cystic duct stones. Endoscopy 2019;51:E354-5. DOI: 10.1055/a-0934-4898.

26. Perissat J, Collet DR, Belliard R. Gallstones: laparoscopic treatment, intracorporeal lithotripsy followed by cholecystostomy or cholecystectomy--a personal technique. Endoscopy 1989;21(Supl. 1):373-4. DOI: 10.1055/s-2007-1012994.

27. Tsuji Y, Ohata K, Gunji T, et al. Endoscopic tissue shielding method with polyglycolic acid sheets and fibrin glue to cover wounds after colorectal endoscopic submucosal dissection (with video). Gastrointest Endosc 2014;79:151-5. DOI: 10.1016/j.gie.2013.08.041.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Table 1. *Patient characteristics*

Baseline characteristics	Total (*n* = 23)
Age, median (range), *years*	41 (35-61)
Sex, male, *n (%)*	9 (39.1)
Indication, *n (%)*	
Persistent or intense right epigastric pain	5 (21.7)
Recurrent right epigastric pain	18 (78.3)
WBC count, median±SD, $10^9/L$	5.8±1.2
Neutrophils percentage, median±SD, *%*	57.6±10
Total bilirubin levels, median±SD, *μmol/L*	8.5±1.3
Imaging results at endoscopic transgastric GPC	
Length of the gallbladder, median (range), cm	6.5 (5.8-8.6)
Width of the gallbladder, median (range), cm	3.2 (2.6-3.9)
Length of the gallstone, median (range), cm	1.5 (1.0-1.8)
Thickness of the gallbladder, range, cm	≤0.4

WBC, white blood cell count; GPC, gallbladder-preserving cholecystolithotomy; SD, standard deviation.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

Table 2. *Clinical results of the two-step hybrid NOTES technique*

	Total (n = 22)
Outcomes	
Successful cholecystogastric stent placement, *n (%)*	22 (95.7) [1]
Removal of gallstones, *n (%)*	22 (100)
Simple cholecystolithotomy, *n (%)*	19 (86.4)
Successful lithotripsy for difficult gallstones, *n (%)*	3 (100)[2]
Retained gallstones, *n (%)*	0 (0)
Wound healing, *n (%)*	22 (100)
Intraoperative complications	
Hemorrhage, *n (%)*	2 (8.7) [1]
Postoperative complications	
CG I	
Increased WBC count, *n (%)*	15 (68.2)
Mild epigastric pain, *n (%)*	9 (40.9)
CG II	
Fever > 38°C managed by antibiotics, *n (%)*	3 (13.6)
CG III	
Perforation, *n (%)*	0 (0)
Biliary peritonitis, *n (%)*	0 (0)
Gallstones recurrence, *n (%)*	2 (9.1)

NOTES, natural orifice translumenal endoscopic surgery; CG, Clavien-Dindo grading.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

[1]Including one patient required conversion to cholecystectomy due to failure of the endoscopic transgastric GPC method.

[2]Including one patient presented with gallstone incarceration in the neck of the gallbladder prior to lithotripsy using an ultraslim endoscope.

Revista Española de Enfermedades Digestivas
The Spanish Journal of Gastroenterology

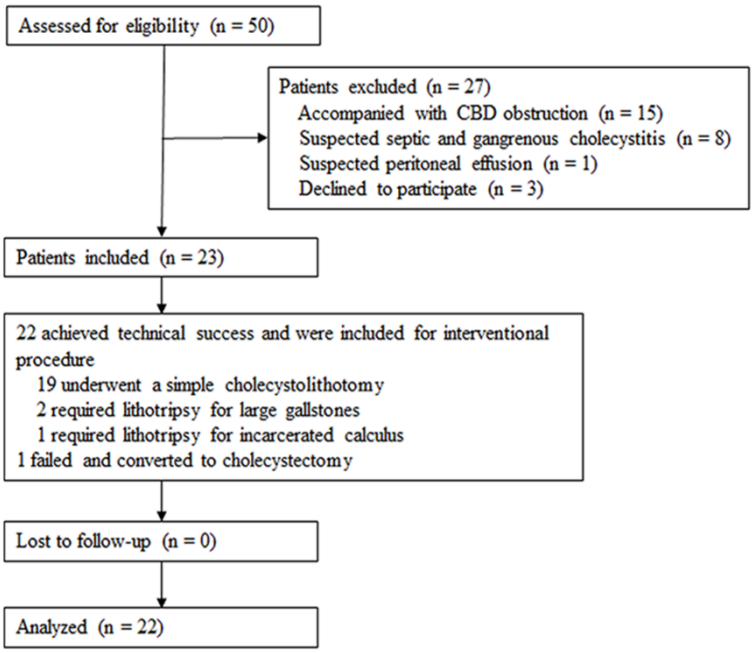

Fig. 1. Flowchart of study subjects. CBD, common bile duct.

Revista Española
de Enfermedades Digestivas
The Spanish Journal
of Gastroenterology

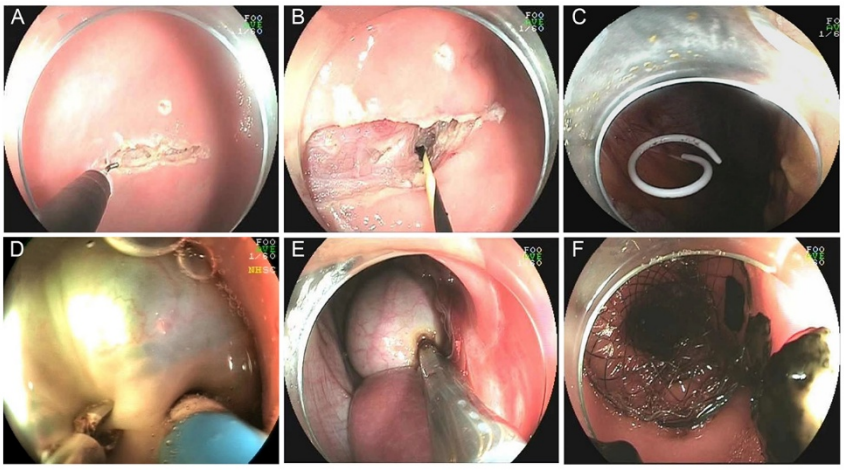

Fig. 2. Endoscopic views showing transgastric NOTES-guided cholecystogastric stent placement: A. A mucosal incision was made using a hook knife. B. A 0.035-inch guidewire was inserted into the abdominal cavity to maintain access. C. A 9F drainage catheter was placed at the right lower quadrant of abdomen. D. The gallbladder was fixed by foreign body forceps, and then thermally punctured under endoscopic visualization. E. The distal stent flange was deployed. F. The proximal flange was deployed, and stones smaller than the inner diameter of the stent were discharged spontaneously. NOTES, natural orifice translumenal endoscopic surgery.

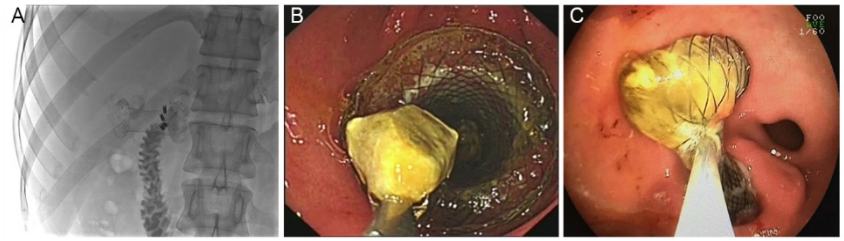

Fig. 3. A. Radiograph showing stent connection between the gallbladder and stomach. B. Endoscopic view showing clearance of gallstones through the cholecystogastric stent. C. Endoscopic view showing removal of the stent with a snare.

Revista Española
de Enfermedades Digestivas
The Spanish Journal
of Gastroenterology

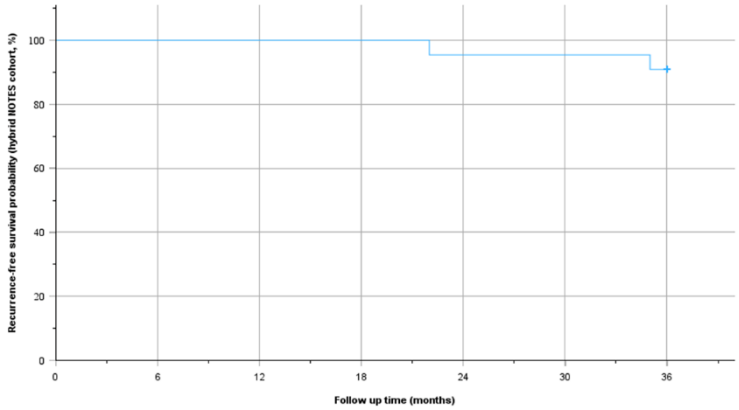

Fig. 4. Kaplan-Meier curve showing recurrence-free survival after hybrid NOTES cholecystolithotomy during 3-year follow-up.