Review Article

Percutaneous transhepatic choledochoscopy in the management of hepatolithiasis: a narrative review

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Background and Objective: From the 1980s and continuing into the 21st century, percutaneous transhepatic choledoscopy (PTCS) has been increasingly used in the clinical management of cholelithiasis. However, when compared to conventional minimally invasive techniques such as endoscopic retrograde cholangiopancreatography (ERCP), PTCS is characterized by greater invasiveness and a higher rate of complications. As a result, PTCS is frequently used as a supplementary treatment option. Nevertheless, it plays a unique and indispensable role in addressing hepatolithiasis. In this study, to facilitate safer clinical applications and gain a deeper understanding of PTCS-related complications, we conducted a comprehensive examination of these complications.

Methods: Research studies related to PTCS were reviewed in PubMed, Web of Science, and China National Knowledge Infrastructure (CNKI) (year range, 1952–2024). There was no restriction on language. The occurrence and management of complications at various steps of PTCS were examined and compared with those of first-line minimally invasive treatments via a tabular method. Additionally, we evaluated the feasibility of using PTCS in the context of intrahepatic bile duct stones.

Key Content and Findings: Information on the types, incidence, and treatment of complications of PTCS was extracted in this review. A total of 5,923 results were retrieved, of which 41 were excluded. The reason for exclusion was that the article was a meeting comment. The findings indicate that PTCS plays an important role in the treatment of biliary tract diseases.

Conclusions: Although PTCS is frequently used as an adjunctive therapeutic approach, its distinct utility in treating intrahepatic bile duct stones remains difficult to replace. Thus, a deeper understanding of PTCS-related complications, coupled with ongoing advancements in instrumentation, could significantly enhance the efficiency of minimally invasive gallstone management.

Keywords: Cholelithiasis; radiology; choledoscopy; percutaneous transhepatic cholangial (PTC)

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Introduction

Cholelithiasis is a fairly a prevalent disease, and within Taiwan, primary hepatolithiasis accounts for approximately 20% of all cases (1). This condition is rare in Western countries but is endemic in East and South Asia, with significant incidence rates observed in China, Japan, and South Korea. There is also an increasing number of cases been reported in Latin America (2-4). Traditionally, the management of hepatolithiasis predominantly involved surgical interventions, such as hepatectomy. However, hepatectomy may not be a feasible option for patients with compromised physical conditions, including older adults or those with hepatic insufficiency. Furthermore, open hepatectomy is associated with potential complications, including intestinal adhesions, obstructions, and the risk of bleeding or gastrointestinal injury during the surgical separation process. It has been reported that the complication rate of robot-assisted hepatectomy is similar to that of laparoscopic hepatectomy and open hepatectomy. Although there is no evidence to suggest that robot-assisted hepatectomy has a lower complication rate in the context of hepatic insufficiency, it may reduce the incidence of major complications when compared to laparoscopic hepatectomy (5). Moreover, hepatectomy, especially right hemihepatectomy, may causes hepatic insufficiency in patients, which can lead to longer hospital stays for patients.

Percutaneous transhepatic choledoscopy (PTCS) is an interventional procedure guided by imaging. It involves the use of a guided wire to create a pathway for lithotomy under an imaging reference. Subsequently, the sinus is expanded, and in some cases, matured to accommodate the insertion of a choledochoscope, with the ultimate goal of achieving intrahepatic lithotomy. PTCS is applicable not only in the treatment of hepatolithiasis but also in patients with common bile duct (CBD) and gallbladder stones (6). Despite its efficacy, PTCS is associated with a residual stone rate ranging from 0.4% to 36.1% (7-10). Postoperative residual stones pose a significant challenge for patients who have undergone PTCS. These residual stones not only worsen the patient's quality of life but have also been linked to an increased mortality rate. Moreover, the excessive removal of stones during the procedure may increase the risk of complications (11).

In the conventional PTCS procedure, percutaneous transhepatic cholangial drainage (PTCD) is performed under local anesthesia and is followed by sequential sinus dilation. This approach is associated with a longer treatment duration and a higher incidence of complications. PTCS lithotripsy (PTCSL) is an alternative method, which can be further categorized into the one-step and two-step approaches, with the one-step approach offering the advantage of shorter treatment times. However, the associated tradeoff is a lower stone clearance rate (79.07% compared to 88.37%), a higher complication rate (30.23% compared to 19.78%), and an increased risk of bleeding. These drawbacks limit the broader application of the one-step approach (12). In order to reduce and prevent the complications of PTCS and better promote the application and development of PTCS in surgery, we conducted a retrospective reading of PTCS related literature, and discussed its complications step by step in the following articles. We present this article in accordance with the Narrative Review reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-24-421/rc).

Table 1 The search strategy

Item	Specification
Date of search	January 5, 2024
Databases and other sources searched	PubMed, Web of Science, CNKI
Search terms used	Percutaneous transhepatic
Timeframe	1952–2024
Exclusion criteria	Meeting comments excluded
Selection process	All authors participated in the selection process

CNKI, China National Knowledge Infrastructure.

Methods

Studies related to PTCS were reviewed in PubMed, Web of Science, and China National Knowledge Infrastructure (CNKI) (year range, 1952–2024). There was no restriction on language, but meeting comments were excluded. The detailed search strategy is presented in *Table 1*.

Complications of PTCS

The complication rate associated with PTCS typically is 7% to 22% (13-16). Notably, PTCS tends to exhibit a higher complication rate in the management of a complex biliary tract. For instance, the reported complication rate for PTCS following hepaticojejunostomy is as high as 45% (17), and in cases of a complete obstruction of the benign biliary stricture, it reaches 50% (18). These complications encompass a range of issues, including hemobilia, cholangitis, bacteremia, biliary peritonitis, vomiting, bloating, and bile leakage. Among these complications, the most commonly encountered are hemobilia (with an incidence of 0–18%) and cholangitis (with an incidence of 1.9–36%) (8,14,17,19). Cholangitis is defined as the onset of fever (>38.5 ℃) within seven days after examination and an increase in inflammation markers requiring antibiotics; peritonitis is diagnosed based on abdominal pain, elevated inflammation markers, and computed tomography (CT) findings; hemobilia is defined as a significant decrease in hemoglobin. Severe complications, such as severe hemorrhage, septic shock, hemoperitoneum, and sinus rupture, are less frequent, occurring in fewer than 8% of cases. Severe complications are defined as any complication leading to additional invasive interventions, admission to hospital, or death. In the analysis of the complication rates for each individual step of the PTCS procedure, the highest rates can be observed in PTCD at 12.9% and sinus dilation at 12.8%. Sinus maturation and therapeutic cholangioscopy exhibit lower complication rates of 6.9% and 6.7%, respectively. It is important to note that complications primarily occur during PTCD and sinus dilation (20,21). Although the complication rate for each step may not be individually substantial, when combined, they can contribute to an overall higher risk (22). In managing these complications, epinephrine and arteriovenous embolization are effective treatments for hemobilia, while antibiotics targeting common biliary tract infections (Gram-negative bacteria and *Enterococcus*) are prophylactically administered to address cholangitis and related infectious symptoms (13,19,23).

PTCD

PTCD is a procedure in which the target bile duct is punctured under the guidance of X-ray or ultrasound (US), which is followed by the insertion of a drainage tube. PTCD serves as both the foundation for PTCS and as a therapeutic technique. Notably, it is often prioritized in the treatment of malignant biliary obstructions (24). In the PTCD process, the initial step involves selecting the puncture approach. Ahmed *et al.* recommend a right-sided approach, which facilitates the procedure for the surgeon (15). On the other hand, Choi *et al.* in a large-scale study, identified the left approach as the sole independent risk factor for hepatic artery injury (25). Despite the left-sided approach being time-consuming, it can reduce the incidence of pneumothorax, making it more suitable for tortuous and narrow bile ducts. As a result, experts have proposed a lesion-specific approach, favoring the left-sided approach for lesions on the left side and the right-sided approach for lesions on the right side. However, choosing the left-sided approach is often preferable for patients with CBD disease or bilateral disease (26). It is crucial to ensure that the puncture point is not exceedingly high, as respiratory movements and intercostal spaces can affect the puncture and increase the risk of pneumothorax (19,27). During PTCD, US guidance is commonly preferred (28), as X-ray guidance relies on anatomical landmarks on the body surface for localization, which can be challenging in patients with altered biliary tract anatomy and poses a higher risk of damaging blood vessels. A comparative study reported a higher success rate with X-ray guidance compared to US guidance (90% *vs.* 86.4%), but it also revealed a higher complication rate (10.6% *vs.* 9.1%), with major complications occurring predominantly in the X-ray-guided group (29). Although CT offers superior clarity, it lacks dynamic imaging capabilities and immediate feedback; however, US can be affected by gastrointestinal gas, and thus X-ray continues to be a valuable diagnostic tool. Notably, oblique fluoroscopy is particularly beneficial for patients without bile dilation (30), and after successful puncture, the drainage tube is typically left in place for 5 to 7 days.

As previously discussed, PTCD is associated with relatively high complication rates, and to provide a more comprehensive overview of the success and complication rates of PTCD under different conditions, several relevant studies have been summarized in *Table 2*. Among the complications encountered during PTCD.

PTCD infection is the most common (20). One study reported that the incidence of infectious complications during PTCD is as high as 40.6% (37). On the other hand, bleeding is relatively uncommon (38). Bleeding can result from injury to the hepatic artery, portal vein, or a branch of the hepatic vein during the puncture process, as depicted in *Figure 1*. Other complications include biliary leakage, displacement or dislocation of drainage tubes, and pleural effusion, among others. In the management of infectious complications, apart from the administration of antibiotics before and after the procedure, close monitoring of physical signs and continuous observation of drainage fluid are essential practices. Although PTCS often involves internal drainage to align with hepatobiliary physiology, it is worth noting that when internal drainage is used with

Table 2 The rate of complications of PTCD under different conditions

Authors	Sample size	Disease	Success rate (%)	Complication rate (%)
Henry *et al.* (31)	65	Pancreaticojejunostomy and/or hepaticojejunostomy	98.0	35.0
Pedersoli *et al.* (32)	187	Dilated bile duct/nondilated bile duct	98.1/92.1	13.0
Kongkam *et al.* (33)	17	Malignant hilar biliary obstruction	100.0	76.5
Nimura *et al.* (34)	133	Hilar cholangiocarcinoma	100.0	23.3
Ciftci *et al.* (35)	30	Intra-abdominal abscess	97.0	20.0
Kubota *et al.* (36)	24	Hilar cholangiocarcinoma	79.0	0

PTCD, percutaneous transhepatic cholangial drainage.

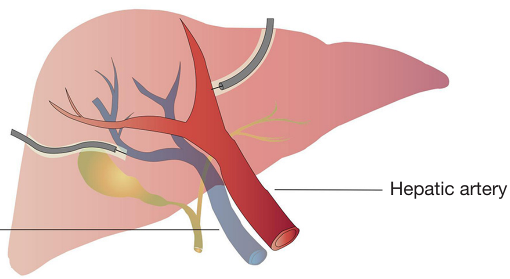

Figure 1 In PTCD, the puncture needles can injure the hepatic artery or portal vein. PTCD, percutaneous transhepatic cholangial drainage.

the drainage tube placed into the duodenum, bacteria can retrograde along the CBD, potentially causing infection. One study suggested that placing a drainage tube in the CBD can help prevent infection (39). External drainage duration should not be excessively prolonged, as excessive bile loss can elevate the risk of infection and even result in the formation of a biliopleural fistula (40). Regarding bleeding complications, PTCD may be performed from the peripheral bile duct under US guidance via a right-sided approach to minimize bleeding. Additionally, direct choledochoscopy can be employed to reduce the risk of bleeding and perforation (15,41-43). In patients with stones, the intrahepatic bile ducts are often dilated, reducing the probability of bleeding during puncture (32). However, patients with biliary malignancies are more susceptible to hemorrhage due to fragile tumor tissues (43). If the bleeding volume is minimal or if venous bleeding occurs, hemorrhaging may be self-limiting and not require treatment, If the bleeding does not stop which can be managed with measures such as epinephrine saline irrigation, catheter repositioning, clamping, or upgrading. In cases where the hepatic artery or portal vein system is accidentally punctured, embolization can be considered a treatment option. Preventing and managing biliary leakage involve positioning the drainage tube close to the bile duct, appropriately opening side holes to reduce bile duct pressure, and preventing bile from entering the abdominal cavity to avert biliary peritonitis. When external drainage is employed, securing the drainage tube firmly to the skin is crucial to preventing dislocation or displacement. Puncture drainage can also be an effective approach for managing pleural effusion and abscesses.

PTCD plays a pivotal role in PTCS and is associated with increased complication rates. PTCD can be used both as treatment and as a diagnostic method for biliary tract tumors (44). Consequently, surgeons must be proficient in this procedure and make extensive use of various imaging techniques to enhance PTCD's safety and efficacy. In a clinical trial of 15 patients, PTCD was performed by radiologists, and no major complications occurred after the operation, indicating that skilled operation may reduce the complication rate, but more evidence is needed to confirm this (45). One valuable approach is the use of preoperative CT scans to meticulously plan the puncture route. It is anticipated that the ongoing advancements in medical technology and equipment will contribute to reducing the complication rate associated with PTCD.

Sinus tract dilation and maturation

After successful guide wire puncture, an 8 F sinus tract is established with the assistance of a dilator. Subsequently, drainage is carried out over the course of one week. After this initial phase, typically within 3–5 weeks and involving 1–3 dilation sessions with a 1–2 Fr increment each time, a larger sinus tract ranging from 14 to 16 F is formed. This expanded tract allows for the direct insertion of a fibercholedochoscope. The traditional PTCS approach is known for its time-consuming nature and a higher incidence of complications, which has led to its gradual decline in use. A comparative study conducted by Tao *et al.* demonstrated that the one-step PTCS method offers advantages in terms of reduced operation time and shorter hospital stays compared to traditional PTCS. Furthermore, compared to traditional PTCS, one-step PTCS exhibits superior treatment outcomes in terms of immediate stone clearance rates (62.9% *vs.* 45.3%) and final stone clearance rates (90.1% *vs.* 78.7%); additionally, the stone recurrence rate is lower in the context of long-term prognosis (13.6% *vs.* 26.7%) (46). In the one-step PTCS approach, following a successful guide wire puncture, the sinus tract is directly dilated to 16 F using a dilator in a single step. Conversely, the two-step PTCS method involves placing a drainage tube under local anesthesia after successful puncture. The 8 Fr sinus tract is then drained for 5 to 7 days. Subsequently, after the sinus tract has matured, the sinus canal is expanded to 16 Fr for PTCS under general anesthesia.

Complications related to sinus tract dilation and maturation predominantly arise from the dilation process itself. The primary complication is the development of infectious diseases, such as cholangitis and bacteremia. In contrast, tract maturation is primarily associated with issues such as catheter migration and blockage (20). Other commonly encountered complications include pain, bleeding, bile leakage, and biliary peritonitis. The one-step method offers expediency, but it is associated with a higher incidence and volume of bleeding, and an immature sinus tract may not be conducive to lithotomy. Conversely, the two-step method is efficient and safe. Chen *et al.* reported a 76.5% clearance rate after the first operation, with a final stone clearance rate of 100% and a 0% rate of bleeding complications (47). Some studies suggest that waiting for the tract to mature is critical (48), while other studies emphasize the need to wait for the tract to mature (49,50). The dilation should be performed slowly to prevent Gall bladder cardiac syndrome, which refers to the clinical syndrome of diseases of the biliary system (cholecystitis, gallstones) and causes coronary artery contraction through spinal reflex, resulting in insufficient coronary blood supply, which can ultimately lead to angina pectoris, arrhythmia, and even myocardial infarction. Thus, the one-step method has gained widespread use in minimally invasive treatments (51,52). To address the issue of tract immaturity in the one-step method, the insertion of a sheath can be employed. This sheath can operate in place of the mature sinus tract, straighten and shorten the choledochoscope lithotomy passage, prevent mechanical damage to the bile duct wall via the lithotomy instrument, reduce the risk of bleeding, prevent bile from flowing into the abdominal cavity—which can lead to bile leakage and biliary peritonitis—and mitigate the chances of excessive washing fluid entering the intestine, potentially causing vomiting (15,53). During the waiting period for tract maturation, timely sinus irrigation can help prevent sheath blockage, and the double-catheter method can be used to prevent sheath displacement.

The application of a cobra-shaped sheath in PTCS has been reported to enhance its efficiency (54), and we believe that PTCS will continue to gain popularity in the future.

Lithotomy and exploration

Bleeding resulting from bile duct injury is the primary complication during lithotomy and exploration (20). In the selection of cholangioscopy type, the choledochofiberscope, traditionally used in PTCS, has been gradually phased out due to its high cost. Instead, rigid cholangioscopy has gained widespread use. Rigid cholangioscopy offers a broader field of vision and higher stone-removal efficiency. However, its limited flexibility makes it challenging to manage complex biliary conditions such as biliary angulation. Therefore, a combination of both types is often employed to ensure comprehensive stone removal. Recently, a soft fiber-optic choledochoscope (Pusheng Medical Co., Ltd., Zhuhai, China) has demonstrated effectiveness in patients with choledocholithiasis, suggesting that the fiber-optic choledochoscope still holds value (55). In the past, it was commonly believed that in the selection of cholangioscope caliber, large stones typically require a larger caliber of cholangioscope for stone extraction, which can lead to higher complication rates (56). With the emergence of modern lithotripsy technologies, such as mesh basket mechanical lithotripsy and electrohydraulic lithotripsy, large-diameter stones can be reduced to smaller-diameter stones, allowing for a smaller-caliber cholangioscope to enter the sinus for lithotripsy. In turn, this can decrease the diameter of sinus dilation and thus reduce the probability of complications such as pain and bleeding. To mitigate complications during biliary tract exploration, especially in therapeutic PTCS (20), a smaller-caliber cholangioscope can be used. However, a study reported a 100% success rate for PTCS in stones larger than 1 cm, with no serious

Table 3 Comparison of stone recurrence rates between PTCS and ERCP

Technique	Authors	Disease	Sample size	Follow-up periods	Recurrence rate (%)
ERCP	Sbeit *et al.* (63)	CBD stone	457	>6 months	9.2
	Wang *et al.* (64)	CBD stone	90	2 years	21.1
	Tan *et al.* (65)	Hepatolithiasis	46	5 (2–8) years	37.0
	Wu *et al.* (66)	CBD stone	1,016	60 months	8.2
PTCSL	Tao *et al.* (46)	Bilateral hepatolithiasis	81	55 (10–63) months	13.6
	Mukund *et al.* (67)	Biliary enteric anastomotic strictures with hepatolithiasis	14	_	0.07
	Tao *et al.* (52)	Biliary strictures with hepatolithiasis	12	15.7±4.5 months	8.3
	Lamanna *et al.* (59)	Hepatolithiasis	10	31 (3–84) months	40.0
	Liu *et al.* (68)	CBD and gallbladder stone	17	2 years	0
PTCS	Tao *et al.* (46)	Bilateral hepatolithiasis	75	55 (10–63) months	20.0
	Wang *et al.* (53)	Hepatolithiasis	51	31.1 (2–85) months	22.0

Follow-up periods are presented as the mean (range) or mean ± standard deviation. PTCS, percutaneous transhepatic choledoscopy; ERCP, endoscopic retrograde cholangiopancreatography; CBD, common bile duct; PTCSL, percutaneous transhepatic cholangioscopic lithotripsy.

postoperative complications (57). In the establishment of a working pathway, the sheath serves the dual purpose of straightening the working pathway of cholangioscopy and preventing the lithotomy instrument from damaging the bile duct wall. In cases of minor bile duct wall bleeding, the sheath can be used for compression to stop the bleeding. Concerning the choice of lithotripsy technology, the success rate of mechanical lithotripsy stands at 82%. Therefore, electrohydraulic lithotripsy is now more commonly employed. However, it carries a higher risk of bile duct wall damage and subsequent bleeding. In recent years, laser lithotripsy has gained acceptance in clinical practice. Laser lithotripsy is considered a safer option, with shorter hospital stays, reduced blood loss, and a lower likelihood of complications (55,58). The success rate of laser lithotripsy can reach 100%, with a first-pass extraction success rate of 92% (59).

Compared to the laparoscopic technique, traditional PTCS involves a longer hospital stay due to the requirement of multiple sinus dilations. But one-step method solves this problem, PTCSL for hepatolithiasis or choledocholithiasis offers several advantages.Compared to laparoscopic choledochotomy lithotripsy, PTCSL demonstrates a higher stone-clearance rate (81.40% *vs.* 66.67%) and is associated with a shorter hospital stay (8 *vs.* 10 days), thereby making PTCSL a more minimally invasive approach (60). Importantly, PTCS can also be effectively employed for CBD stone extraction, with a technical success rate as high as 90.2% for patients who have gastrointestinal anatomical changes and are unable to undergo endoscopic retrograde cholangiopancreatography (ERCP) (61). Consequently, PTCS may be an option for supplementing treatment after failure of ERCP (62).

Postoperation

Stone recurrence post-PTCS remains a persistent concern for patients. To provide a concise assessment of PTCS efficacy in managing intrahepatic and extrahepatic stones, the stone recurrence data for PTCS versus that of ERCP for the first-line treatment of biliary tract diseases is presented in *Table 3*. The table shows that the stone recurrence rate for PTCSL in cholelithiasis treatment surpasses that of conventional PTCS and slightly outperforms ERCP. This discrepancy may be attributed to the limited sample size in the study.

Postoperative stone recurrence is influenced by various factors, with biliary stricture being the most significant (13,69). Addressing biliary strictures has become a crucial strategy for preventing stone recurrence. In cases of biliary stricture, such as membranous strictures (length <2 mm), direct dilation using cholangioscopy is recommended. For tubular stenosis (length >5 mm), balloon catheter dilation is typically employed. However, balloon catheters may not effectively treat severe stenosis (70). Addressing biliary strictures has become a crucial strategy for preventing stone recurrence. In cases of biliary stricture, such as membranous strictures (length <2 mm), direct dilation using cholangioscopy is recommended. For tubular stenosis (length >5 mm), balloon catheter dilation is typically employed. However, balloon catheters may not effectively treat severe stenosis (71,72). In contrast to conventional metal stents, patients often exhibit poor compliance with traditional silastic stents, leading to persistent stenosis after implantation (73). However, a novel retrievable covered stent has shown promise, yielding a 10-year biliary patency rate of 54.5% (74).

Regarding the management of postoperative drainage tubes, the presence of an indwelling drainage tube serves multiple purposes, such as helping to prevent the occurrence of cholangitis and enabling timely monitoring and irrigation in mitigating complications such as bleeding, infection, catheter displacement, and dislocation. Additionally, if necessary, the drainage condition can be assessed through cholangiography (75).

Comprehensive application and development of PTCS

The management of complex biliary tract conditions remains challenging. Various techniques, including PTCS, ERCP, or surgery, can be used individually, but often a combination of these approaches is necessary. In recent years, laparoscopic choledochoscopy has also been incorporated into intrahepatic bile duct lithotomy, which is equally effective in the face of complex intrahepatic stones. It has been reported that during laparoscopic choledochoscopy, the success rate of the 3-mm scope entering the liver is 70%, and that of the 5-mm scope is 81% (76). The use of ERCP may be problematic for addressing complex intrahepatic stones and severe strictures. In such cases, PTCS can be used, and rendezvous technology may be implemented to facilitate the procedure. One study has confirmed the safety of combining PTCS and ERCP (42). Furthermore, reports indicate that ERCP, when coupled with percutaneous choledochoscopy, can be effectively applied in challenging cases involving intrahepatic bile duct stones (77). Choledochoscopy is widely adopted, and the combination of PTCS with postoperative choledochoscopy has proven beneficial in addressing postoperative residual stones (78,79).

Significant advancements have been observed in PTCS over time, with the widespread adoption of the Spyglass choledochoscope (Boston Scientific, Natick, MA, USA) in recent years (80,81). The Spyglass choledochoscope offers four-way steerability, surpassing conventional choledochoscopes and effectively reducing the complications associated with PTCS sinus tract dilation (82,83). For the Spyglass choledochoscope, sinus dilation to 10–12 Fr is sufficient, which may be one reason for the reduced complication rate (84). Additionally, a single-operator choledochoscope (SOC) based on the Spyglass system is now in clinical use. Compared to the fiber Spyglass system, SOC boasts a higher resolution and a wider field of view (85). Several experts reported that PTCS is more suitable for a two-operator approach (83). However, more recent reports suggest that SOC combined with laser lithotripsy yields superior therapeutic outcomes for intrahepatic bile duct stones. Furthermore, patients experience faster postoperative recovery, with some being discharged from the hospital as early as the second day after surgery (86). Thus, SOC has gained acceptance among surgeons for the treatment of intrahepatic bile duct stones and due to its diagnostic value in benign and malignant biliary diseases. In an observational study involving 40 patients, SOC was used to pathologically diagnose these diseases, with only one case with a diagnosis differing from that of pathological diagnosis (87). Another study reported an overall accuracy of 96.4% with SOC based on visual impressions (11). In a follow-up evaluation of SOC use in PTCS, the technical success rate reached 100%, with a complication rate of only 19.6% at a median follow-up of 7 months (88).

Conclusions

In the field of minimally invasive medicine, PTCS remains a second-line treatment option for cholelithiasis and has an indispensable function in managing intrahepatic stones despite being associated with a high level of invasiveness and a propensity for complications. However, as PTCS evolves and its limitations are progressively addressed, it is anticipated that PTCS will emerge as a significant therapeutic approach for biliary tract disorders and be potentially extended to the broader domain of the digestive system.

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Footnote

Reporting Checklist: The authors have completed the Narrative Review reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-24-421/rc

Conflicts of Interest: Both authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-24-421/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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