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ORIGINAL ARTICLE

Percutaneous Transhepatic Biliary Stones Removal — An Effective and Safe Alternative

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ABSTRACT

Introduction: *Percutaneous transhepatic biliary stone removal is a well-established treatment for biliary stone disease, as an alternative to the standard endoscopic or surgical approaches. We present our experience in biliary stone removal via the percutaneous transhepatic route, focusing on the techniques, clinical success rate, and complications.*

Methods: *Data on all percutaneous transhepatic biliary stone removals performed at our institution between January 2014 and May 2017 were extracted from patient records. Clinical outcomes, procedure success rate, and complication rate were analysed.*

Results: *In total, 33 procedures were performed in 27 consecutive patients (24 men, 3 women, median age 78.0 years; range, 55-92 years). Reasons for percutaneous transhepatic biliary stone removal included contra-indication to or failure of endoscopic removal (prior gastrectomy or duodenal surgery, n = 19; failed endoscopic retrograde cholangiopancreatography cannulation, n = 3; duodenal stenosis, n = 3; and hepaticojejunostomy stricture, n = 1), and one patient had intrahepatic ductal stones not amenable to endoscopic removal. The overall clinical success rate was 90.9%, with an initial procedure success of complete ductal clearance achieved in 24 cases (72.7%) after the first attempt. Stone removal was unsuccessful in two cases, and incomplete stone removal was present in one case, which were all related to unfavourable biliary anatomy. There were no significant complications (0%) or mortality (0%). The mild complication rate was 15.2% (mild haemobilia, n = 5).*

Conclusion: *Percutaneous transhepatic biliary stone removal is an effective and safe procedure. It is a reliable alternative for patients when endoscopic or surgical approaches are not feasible or unsuccessful.*

Key Words: *Catheters; Choledocholithiasis/TH; Radiology, interventional/IS; Safety; Surgical endoscopy*

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Contributors: JHMC and WKWL designed the study. JHMC, BKHL and BSTL acquired the data. JHMC analysed the data. JHMC and AHCW drafted the manuscript. WKWL, CYC and WKK critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

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中文摘要

經皮經肝膽道結石切除術：有效且安全的替代方法

鄭希敏、梁錦榮、黃可澄、李家灝、梁肇庭、朱志揚、簡偉權

引言：經皮肝穿刺膽道結石切除術是一種公認的膽道結石治療方法，可替代標準內窺鏡或手術方法。本文介紹通過經皮經肝切除膽管結石的經驗，其中重點包括技術、臨床成功率和併發症。

方法：從患者記錄中提取2014年1月至2017年5月期間在本院進行所有經皮經肝穿刺膽道結石切除術的數據。分析臨床結果、手術成功率和併發症發生率。

結果：共27例患者進行33次手術（男24例，女3例，年齡介乎55-92歲，中位年齡78.0歲）。進行經皮經肝膽管結石切除術原因包括內鏡切除術禁忌或失敗（19例曾進行胃切除術或十二指腸手術、3例內鏡逆行胰膽管造影插管失敗、3例十二指腸狹窄以及1例肝空腸造口狹窄），1名患者的肝內導管結石不適合內鏡下摘除。總體臨床成功率為90.9%，首次嘗試後的24例（72.7%）患者成功完成導管清除術。結石清除不成功2例，結石清除不完全1例，均與膽道解剖結構不良有關。沒有嚴重併發症（0%）或死亡（0%）。輕度併發症發生率為15.2%（輕度血友病5例）。

結論：經皮經肝膽道結石切除術是一種安全有效的方法。當內窺鏡或手術方法不可行或不成功時，它是患者的可靠選擇。

INTRODUCTION

Biliary duct stone disease, or choledocholithiasis, is the commonest cause of non-malignant biliary obstruction, occurring in 10% of the adult population and up to 14.7% of post-cholecystectomy patients.[1-4] Recommended first-line treatments for choledocholithiasis include endoscopic retrograde cholangiopancreatography with sphincterotomy, and laparoscopic common bile duct exploration.[5] In Hong Kong, the endoscopic approach is the primary modality in the current standard of practice, followed by surgical exploration of common bile duct. However, there are situations where endoscopic or surgical approaches are not feasible or unsuccessful, and the percutaneous transhepatic approach offers an invaluable alternative for biliary stone removal.

We present our experience in biliary stone removal via the percutaneous transhepatic route, with the discussion focusing on the techniques, clinical success rate, and complications.

METHODS

All 27 consecutive patients with symptomatic choledocholithiasis who underwent a total of 33 sessions of percutaneous transhepatic removal of biliary stones in our department from January 2014 to May 2017 were included and retrospectively reviewed.

The electronic patient records, laboratory results, and interventional procedure records were evaluated. The computed tomography and interventional procedure fluoroscopic images were reviewed through the PACS system. The patients were followed up for a mean (±standard deviation) period of 19.5±10.8 months. Procedure success was defined as achieving ductal clearance, and clinical success was defined as improvement in clinical condition and liver function. Procedure-related complications were defined as adverse events occurring within 30 days after the procedure.

Technique

A percutaneous transhepatic biliary drainage (PTBD) catheter was usually inserted for bile drainage and decompression of the biliary tree 1 to 2 weeks before the procedure. This aided in reducing ductal wall and sphincter of Oddi oedema, aiding the subsequent stone removal procedure.

Just as with other interventional biliary procedures, all patients were administered prophylactic parental broad-spectrum antibiotics, given 24 hours prior and on the day of the procedure. A dose of 25 to 100 μg of intravenous fentanyl was administered to achieve adequate analgesic effect, especially during balloon dilatation for sphincteroplasty. Preprocedural blood tests included a complete blood count and clotting profile. Any coagulopathy was corrected based on the Consensus Guidelines for Coagulation Status and Hemostasis Risk for category 3 procedures, i.e., international normalised ratio ≤1.5 and platelets ≥50 × 10^9/L.[6]

A preprocedural cholangiogram was performed via the PTBD catheter, confirming the presence, number, and location of biliary stones, as well as the status of the papilla of Vater and the anatomy of the biliary drainage pathway. A flexible introducer sheath (8-Fr Super Arrow-Flex sheath, Teleflex Medical, Athlone, Ireland) was introduced into the biliary tree after exchange over a 0.035-inch stiff guidewire (UltraStiff guidewire, Cook Medical, Bloomington [IN], US; Super Stiff guidewire, Boston Scientific, Natwick [MA], US). Passage of a stiff guidewire through the sheath to the duodenum followed, to straighten the path and facilitate stone removal. Papillary balloon dilatation (sphincteroplasty) was then performed with an angioplasty balloon (Mustang balloon dilatation catheter; Boston Scientific, Natwick [MA], US), with balloon size ranging from 8 to 12 mm. The balloon was inflated with diluted contrast material until the waist at the papillary sphincter disappeared. The balloon catheter was then deflated and removed with care to avoid retraction of stones into the peripheral ducts. A 6- to 7-Fr Fogarty balloon catheter (Edwards Lifesciences, Irvine [CA], US) was introduced over the guidewire with the balloon inflated proximal to the biliary stones. The Fogarty balloon was inflated with air and advanced further over the guidewire to expel the biliary stones into the duodenum. Air was used instead of contrast material to provide negative contrast within the contrast-filled biliary tree. In addition, inflation with air renders the balloon more easily compressible so that it can more easily cross the sphincter during stone removal. This manoeuvre was repeated several times if necessary to achieve complete ductal clearance (Figure 1).

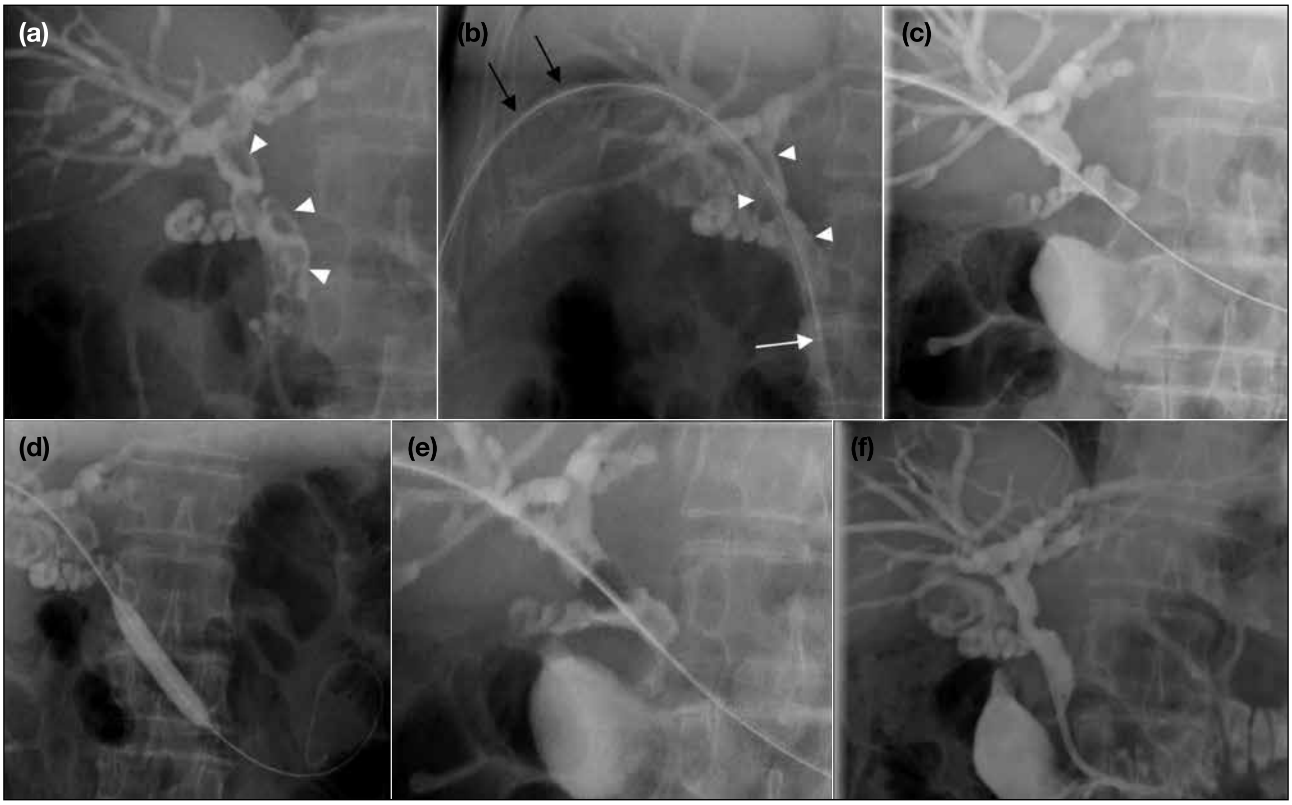

Figure 1. (a) Preprocedural cholangiogram via a pre-inserted right internal-external percutaneous transhepatic biliary drainage catheter showing presence of several stones (arrowheads) in the dilated common bile duct (CBD); (b) An introducer sheath (black arrows) was inserted over the guidewire into the biliary system, with the tip of the sheath (white arrow) located proximal to the ductal stones (arrowheads); (c) Passage of a 0.035-inch Amplatz Super Stiff guidewire through the sheath to the duodenum to straighten the path; (d) Papillary balloon dilatation performed with a Mustang 10 mm × 40 mm balloon, with the balloon inflated with dilute contrast until the waist at the papillary sphincter disappeared; (e) A 7-Fr Fogarty balloon catheter was inflated with air proximal to the stones and advanced over the guidewire for antegrade stone expulsion into the duodenum. This manoeuvre was repeated till ductal clearance; (f) Postprocedural cholangiogram showing no residual filling defects in the CBD with free flow of contrast medium into the duodenum, confirming ductal clearance.

At the end of each procedure, cholangiography was performed to evaluate for any residual stones. After ductal clearance of stones, an internal-external PTBD catheter was then inserted for temporary biliary drainage. A follow-up cholangiogram in about 2 to 4 weeks after the procedure was scheduled for all patients, and removal of the PTBD catheter could be considered if ductal clearance was confirmed.

RESULTS

In total, 33 procedures were performed in 27 consecutive patients (24 men, 3 women, median age, 78.0 years; range, 55-92 years) and data on these procedures were retrospectively reviewed.

The most common presenting symptom in our cases was cholangitis (n = 21), followed by biliary pancreatitis (n = 4), biliary colic (n = 1), and persistently abnormal liver function (n = 1).

The reasons for percutaneous transhepatic biliary stone removal in our cases were mainly related to endoscopic contra-indications or failures, including prior gastrectomy or duodenal surgery (n = 19), failed endoscopic retrograde cholangiopancreatography cannulation (n = 3), duodenal stenosis (n = 3), or hepaticojejunostomy stricture (n = 1); and intrahepatic duct (IHD) stones not amenable to endoscopic removal (n = 1).

The locations of calculi included extrahepatic (n = 28), intrahepatic (n = 1), mixed intra- and extra-hepatic (n = 3) and cystic duct remnant (n = 1). The mean diameter of calculi was 11.7±5.4 mm.

Complete removal of stones was achieved in 24 cases (72.7%) after the first attempt. Six patients had residual stones after the first procedure and were scheduled for a second session after several days to weeks, and subsequent complete ductal clearance were achieved in five additional cases (87.9%). One case had tiny residual stones in the left IHD, which spontaneously passed, giving an overall clinical success rate of 90.9%. Stone removal was unsuccessful in two cases and partial ductal clearance was achieved in one case.

Preprocedural obstructive derangement of liver function tests was present in 12 cases, with improvement noted after biliary stone removal in 10 cases, while the remaining two cases showed static results.

There were no adverse events such as bile duct or duodenal perforation, cholangitis, pancreatitis, vascular injury, or mortality encountered in any of our cases. Mild haemobilia was encountered in five cases (15.2%), which were detected during the procedure and spontaneously resolved without further intervention. The median procedure time was 45 minutes (range, 20-140 minutes).

In one case with a hepaticojejunostomy anastomosis stricture complicated by biliary stones, the same technique was performed with balloon catheters placed across the stricture for dilatation (9 mm × 40 mm Mustang balloon catheter, Boston Scientific, Natwick [MA], US). Subsequent antegrade stone expulsion through the hepaticojejunostomy into the jejunum was similarly performed with a Fogarty balloon catheter. Small residual stones in the left IHD were noted on postprocedural cholangiography, with spontaneous passage confirmed on subsequent cholangiography (Figure 2).

A case of known recurrent pyogenic cholangitis complicated by a left IHD stricture and multiple IHD stones had stricture dilatation and antegrade stone expulsion performed in a similar manner (Figure 3).

In addition to the stone expulsion procedures described above, five cases required further manipulation with stone fragmentation performed. With stones >12 mm in diameter, we performed stone fragmentation by mechanical lithotriptor (LithoCrushV, Olympus Medical Systems, Tokyo, Japan) to facilitate antegrade expulsion into the duodenum. An introducer sheath with larger French size (9-10 Fr) was required to introduce the mechanical lithotriptor. We used a mechanical lithotriptor (LithoCrushV, Olympus) to capture and crush the large stones. This device was intended to be used via an endoscopic approach. However, it was not user-friendly when used via a percutaneous approach, with extensive length hanging outside the body. After fragmentation of the large stones into smaller sizes, the stones were expelled into the duodenum by the usual Fogarty technique (Figure 4).

DISCUSSION

Endoscopic management of biliary stone disease in combination with endoscopic sphincterotomy is a well-established treatment and often the first-line modality for stone removal, with a high success rate up to 90% in the hands of experienced endoscopists.[4] However, in situations where the endoscopic approach is unfeasible (e.g., patients with prior gastrectomy, duodenal stenosis, IHD stones), or when endoscopic biliary access is unsuccessful, percutaneous stone removal is another well-known non-operative technique for treatment of biliary stones.

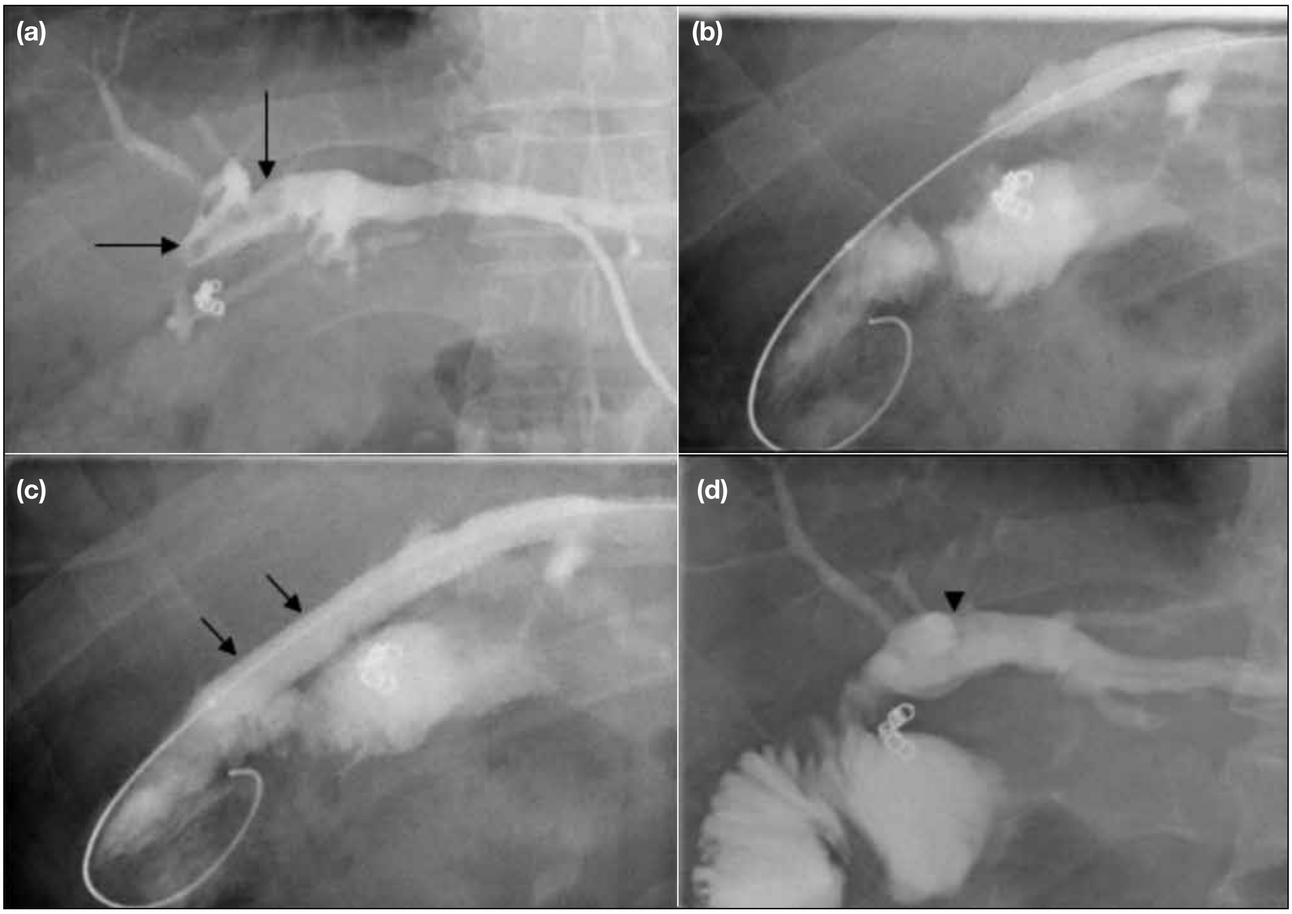

Figure 2. (a) Preprocedural cholangiogram showing a tight stricture at the hepaticojejunostomy with filling defects in left intrahepatic ducts (IHD) [arrows], suggestive of ductal stones. No contrast passage to the jejunum was observed. Coils in the image were related to prior embolisation of right hepatic artery pseudoaneurysm; (b) Exchange for an introducer sheath with passage of a guidewire through the hepaticojejunostomy; (c) Balloon dilatation of the hepaticojejunostomy stricture (arrows); (d) Cholangiogram after stricture dilatation and stone expulsion showing prompt contrast passage through the hepaticojejunostomy suggesting successful dilatation. Tiny residual filling defects at the left IHD noted (arrowhead), suggestive of residual stones.

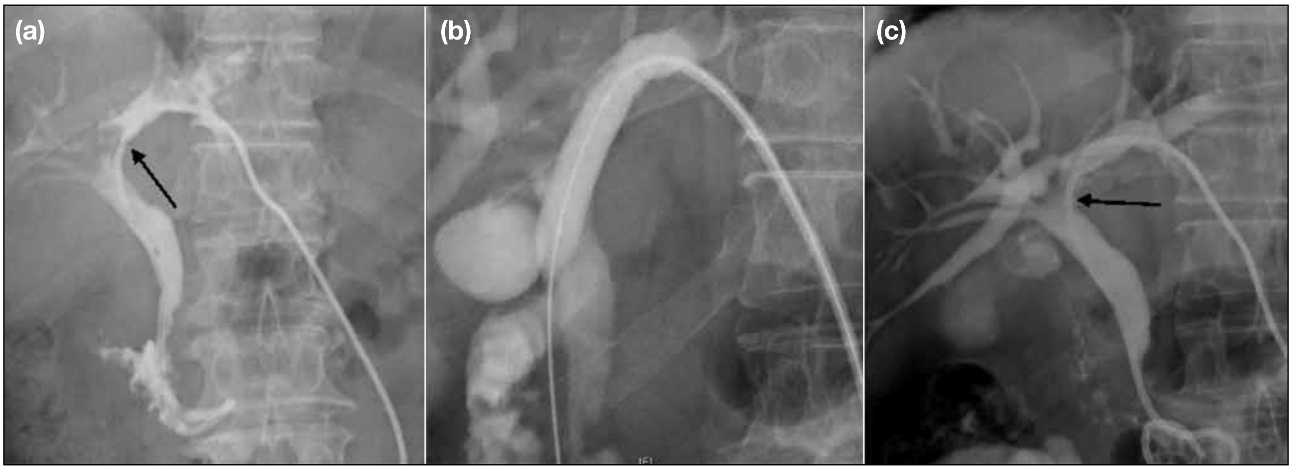

Figure 3. (a) Preprocedural cholangiogram showing a dilated left intrahepatic duct (IHD) with proximal stricture and multiple filling defects suggestive of stones; (b) Balloon dilatation of the left IHD stricture was performed, followed by antegrade stone expulsion into the common bile duct and duodenum; (c) Postprocedural cholangiogram showing successful dilatation of left IHD stricture dilatation with ductal clearance.

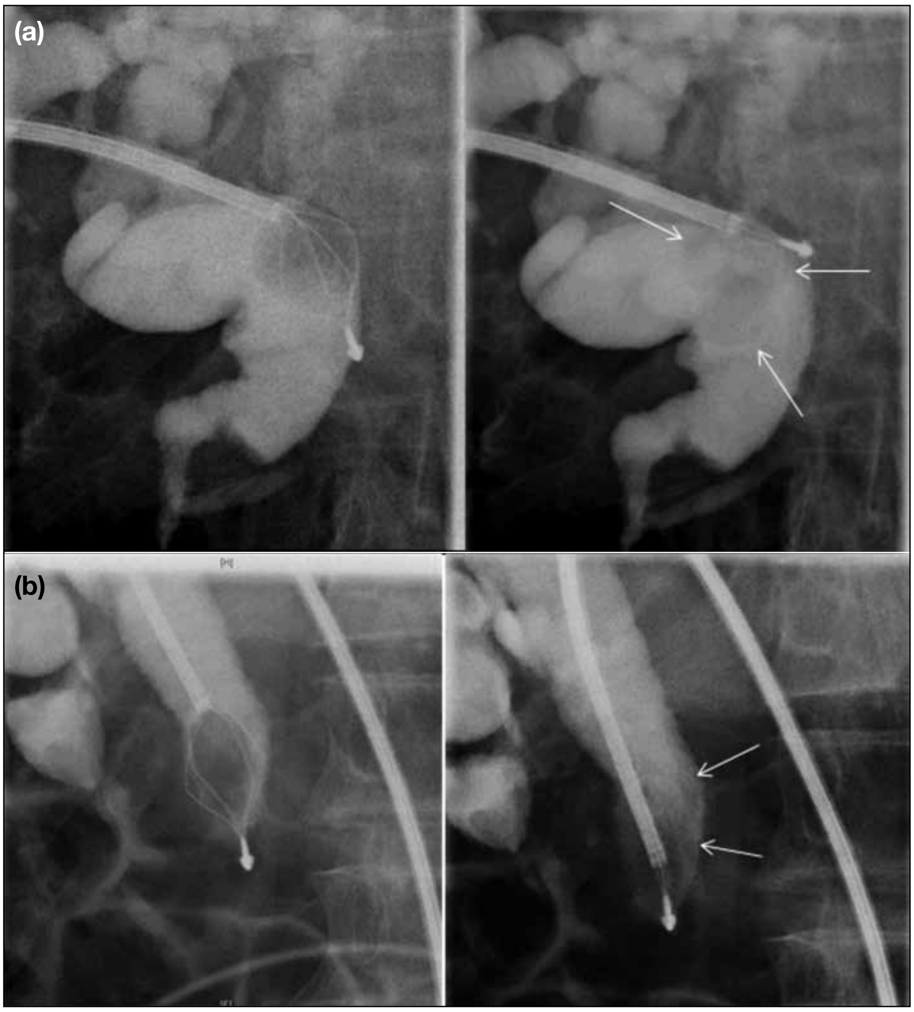

Figure 4. Mechanical lithotripsy of large common bile duct (CBD) stone in two different patients (a and b). The large CBD stone was crushed into smaller fragments (arrows in a and b), facilitating subsequent antegrade expulsion through the papilla into the duodenum.

The percutaneous approach to biliary stone removal was first introduced by Mondet in 1962[7] and Mazzariello in 1970[8] using articulated forceps, and later modified by Burhenne et al[9] with the additional use of biliary baskets. Their methods were effective with success rates up to 95%, however, their approaches required substantial tract dilatation. A modified technique of percutaneous stone removal with aid of balloon papillary dilatation was later proposed by Centola et al in 1981.[10] This approach was also confirmed to be safe and effective by several studies.[11-19]

In our institution, we were able to achieve a high success rate with a high safety profile in the percutaneous transhepatic approach of biliary stone removal. The overall clinical success rate was 90.9%. The initial procedure success rate was 72.7% after the first attempt and 87.9% after the second attempt in achieving complete ductal clearance. Our experience was comparable to other studies, with reported success rates of 86.7% to 96%.[11-19]

We only had two cases of treatment failures and one case of partial ductal clearance, all related to unfavourable biliary ductal anatomy rendering difficult lithotripsy and stone expulsion. One case had a capacious cystic duct remnant leading to repeated migration of mobile stones back to the remnant, and the other two cases were of large stones (mean diameter = 20 mm) within a tortuous biliary duct leading to ineffective mechanical lithotripsy and antegrade stone expulsion (Figure 5).

We did not have any significant procedure-related complication (0%) or mortality (0%), including bile duct or duodenal perforation, cholangitis, pancreatitis, or vascular injury. The minor complication rate was 15.2%,

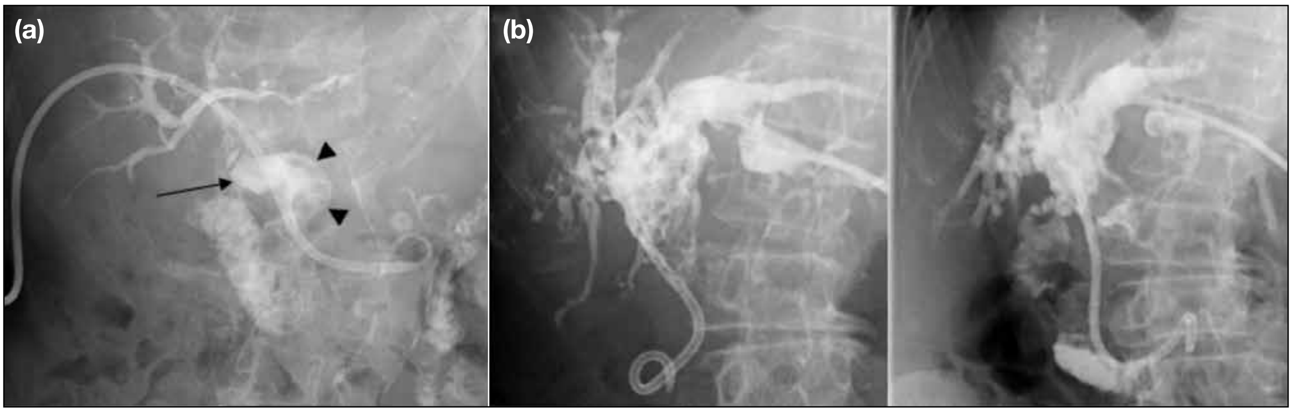

Figure 5. (a) Case 1: Cholangiogram of a post-cholecystectomy patient via right percutaneous transhepatic biliary drainage catheter. Several filling defects suggestive of stones are seen (arrowheads), which repeatedly migrated back to the large cystic duct remnant (arrow), rendering lithotripsy and stone expulsion difficult; (b) Case 2: (left) Preprocedural cholangiogram showing numerous stones within bilateral intrahepatic ducts (IHD) and common bile duct (CBD). Tortuosity of biliary ducts and peripheral locations of the IHD stones render difficult lithotripsy and stone expulsion; (right) Postprocedural cholangiogram showing partial removal of CBD stones with spontaneous antegrade contrast passage to duodenum.

which were all mild haemobilia encountered during the procedure that spontaneously subsided without further intervention.

The reported significant complication rates in other studies range from 0% to 6.8%. The more common ones were severe haemobilia resulting in organ failure or death, cholangitis, and pancreatitis. Other rare significant complications included liver abscess and vascular injury (right hepatic artery transection, pancreaticoduodenal artery pseudoaneurysm, common bile duct or duodenal perforation, and mortality).[15-19]

Other Techniques

Various percutaneous techniques of biliary duct stones removal have been described in the literature, including stone extraction by forceps or baskets; antegrade expulsion of stones into the duodenum by forceful irrigation, or with the aid of various angioplasty balloon catheters, with or without stone fragmentation; chemolitholysis; papillary balloon dilatation (sphincteroplasty); and stricture dilatation.[1,3,10,20,21]

We preferred the method of antegrade stone expulsion over percutaneous transhepatic stone extraction, due to the potential injury to the liver parenchyma adjacent to the tract associated with the stone extraction procedure and the high effectiveness of antegrade removal.[1]

All of our cases had PTBD performed several days to weeks prior to the stone removal, to allow time for biliary sepsis and/or papillary sphincter oedema to resolve.[1]

We also performed balloon sphincteroplasty in all cases, which is reported to be highly effective in facilitating subsequent stone removal.[11-15] Mechanical expulsion of stones through the ampulla of Vater without sphincter dilation has been reported; however, it was found to be associated with higher rates of postprocedural pancreatitis due to difficulty in pushing stones against the non-dilated papilla resulting in buckling of angioplasty balloons or baskets.[22-24] In addition, it was also less traumatic as compared with the conventional endoscopic sphincterotomy, with major advantages of lower risk of sphincterotomy-induced bleeding and preservation of sphincter function, which have been proven by manometric studies.[25] Some studies also reported lower rate of pancreatitis (0%-1.5%) as compared with sphincterotomy or even retrograde sphincteroplasty (4%-35%).[15,18,19]

The selection of angioplasty balloon diameter for sphincteroplasty was based on the size of ductal stones and the common bile duct itself. We avoided selection of large balloon sizes and inflation of balloons exceeding 14 mm in diameter, in order to minimise the risk of common bile duct perforation.[19]

In a few cases, the basic procedures described were insufficient for complete stone removal, particularly the larger stones. In these cases, we adopted additional manoeuvres, including advancement of the Fogarty balloon catheter together with the introducer sheath to strengthen the pushing force, and/or using a balloon of larger size for sphincteroplasty. In several cases, we also performed additional stone fragmentation by mechanical lithotripsy. Other reported techniques of stone size reduction include contact chemolitholysis with monooctanoin, stone dissolution with methyl tertbutylether, and other mechanical fragmentation techniques such as electrohydraulic, laser, ultrasonic shock waves, and electromagnetic waves.[1,12,15,20,26]

Finally, at the end of the procedure, due to the transient oedema or spasm of the papilla after sphincteroplasty, potential blockage of the biliary and pancreatic drainage pathway might occur. Hence, an internal-external PTBD catheter is inserted in all of our cases to ensure satisfactory biliary drainage to minimise the risk of cholangitis or pancreatitis.[16,18]

The limitations of our study are the retrospective nature and relatively small sample size, limiting the evaluation of rare but significant complications that were reported in the literature.[15-19]

CONCLUSION

In conclusion, our study demonstrated that percutaneous transhepatic antegrade biliary stone removal with balloon sphincteroplasty is an effective and safe procedure for treatment of biliary stones. It is an alternative for patients when the endoscopic or laparoscopic approach is not feasible or unsuccessful, and we encourage the practice of this technique, as a minimally invasive treatment option before consideration of surgical exploration.

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