

Biliary exploration via the left hepatic duct orifice versus the common bile duct in left-sided hepatolithiasis patients with a history of biliary tract surgery

A randomized controlled trial

Yong Zhou, MD^a, Wen-Zhang Zha, MD^{a,*}, Xu-Dong Wu, PhD^{b,*}, Ren-Gen Fan, PhD^a, Biao Zhang, PhD^a, Yong-Hua Xu, PhD^a, Cheng-Lin Qin, MD^a, Jing Jia, MD^c

Abstract

Background: Hepatectomy and additional common bile duct exploration are required for the treatment of left-sided hepatolithiasis (LSH).

Methods: Eligible LSH patients (n=62) scheduled for open left lateral segmentectomy or left hemihepatectomy with intraoperative biliary exploration via the left hepatic duct orifice (LHD group, n=35) or the common bile duct (CBD group, n=27) were retrospectively studied. T-tube insertion was performed on selected patients. Primary outcome measures included overall operative time, length of hospital stay, intraoperative complications, residual stones, and postoperative bile leaks.

Results: There were no residual stones observed in the 2 groups. Ten patients in the CBD group received T-tube placement, whereas no patients in the LHD group received T-tube placement. There were more patients in the CBD group suffered intraoperative complications and postoperative bile leakage than LHD group ($P < .05$). The LHD group had a significantly shorter operative time and hospitalization than the CBD group ($P < .05$).

Conclusion: For left-sided hepatolithiasis patients with a history of biliary tract surgery, LHD cholangioscopy is an accessible technique that simplifies the operation procedure by avoiding choledochotomy and subsequent T-tube insertion, which results in lower complication rates as well as shorter operative duration and length of hospitalization.

Abbreviations: CBD = common bile duct, ERCP = endoscopic retrograde cholangiopancreatography, EST = endoscopic sphincterotomy, LSH = left-sided hepatolithiasis, MRCP = magnetic resonance cholangiopancreatography, UIN = Unique Identifying Number.

Keywords: bile duct exploration, biliary operation history, choledochotomy, left hepatic duct (LHD) orifice, left-sided hepatolithiasis, LHD cholangioscopy

Editor: Yan Li.

W-ZZ and X-DW contributed equally to the study.

This work was supported by the Jiangsu Provincial Young Talents Program of Medicine (Grant no. QNRC2016471).

The authors have no conflicts of interest to disclose.

^a Department of General Surgery, ^b Department of Gastroenterology,

^c Department of Nephrology, Yancheng City No. 1 People's Hospital, Yancheng, Jiangsu Province, China.

* Correspondence: Wen-Zhang Zha, Department of General Surgery, Yancheng City No.1 People's Hospital, 16 Yuehe Road, Yancheng 224005, Jiangsu Province, China (e-mail: zhawenzhang@sina.cn), Xu-Dong Wu, Department of Gastroenterology, Yancheng City No.1 People's Hospital, 16 Yuehe Road, Yancheng 224005, Jiangsu Province, China (e-mail: hnjsycwxd@163.com).

Copyright © 2018 the Author(s). Published by Wolters Kluwer Health, Inc. This is an open access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

Medicine (2018) 97:3(e9643)

Received: 23 October 2017 / Received in final form: 21 December 2017 /

Accepted: 27 December 2017

<http://dx.doi.org/10.1097/MD.0000000000009643>

1. Introduction

Primary hepatolithiasis is a prevailing biliary disorder in the East and Southeast Asian populations.^[1,2] Left-sided hepatolithiasis accounts for the majority of cases that require left hepatectomy after long-term recurrent cholangitis and subsequent parenchymal atrophy. Furthermore, patients with left-sided hepatolithiasis usually have concomitant right-sided hepatolithiasis or choledocholithiasis.^[3] Therefore, additional bile duct exploration and stone extraction are required in these cases. However, some patients with left-sided hepatolithiasis have undergone several prior biliary tract surgeries to address gallstones prior to receiving left hepatectomy, which may make it difficult to dissect the common bile duct.

The best modality established for the treatment of left-sided hepatolithiasis is hepatectomy of the involved liver segments.^[4,5] Following left hepatectomy, a path for the cholangioscope to access the common bile duct (CBD) via the left hepatic duct (LHD) orifice is revealed. This approach has been used in the laparoscopic treatment of left-sided hepatolithiasis, which has significantly reduced the occurrence of intraoperative complications and accelerated postoperative recovery compared with conventional choledochotomy.^[6,7]

The purpose of this study was to present our early experiences with bile duct exploration in left-sided hepatolithiasis patients with concurrent right-sided hepatolithiasis or choledocholithiasis, focusing on the patients with a history of biliary tract surgery.

2. Patients and methods

This study was registered in <http://www.researchregistry.com/> and the Research Registration Unique Identifying Number (UIN) is research registry 2998.

2.1. Patients

Between January 2012 and June 2016, a total of 192 patients who were referred to our institution for management of hepatolithiasis were retrospectively studied. We included 62 left-sided hepatolithiasis patients with a history of biliary tract surgery and with concomitant right-sided hepatolithiasis or choledocholithiasis (Fig. 1). These 62 patients, including 15 males and 47 females with a median age of 51.5 years (range=36–78 years), were scheduled for left lateral segmentectomy or left hemihepatectomy with intraoperative biliary exploration through the LHD orifice (LHD approach, LHD group, n=35) or the common bile duct (CBD approach, CBD group, n=27). The patients were well informed of the advantages and disadvantages of the 2 approaches and gave informed consent prior to surgery. The assignment to each approach was at the discretion of the patient himself or herself. The presence or absence of bile duct stones and the diameter of the CBD were determined by preoperative ultrasonography and magnetic resonance cholangiopancreatography (MRCP) in all patients. Table 1 shows the baseline characteristics of the LDH group (n=35) and the CBD group (n=27). The patients with acute pancreatitis, cholangitis, and jaundice were treated before the operation. Comorbid conditions, previous operations, presenting symptoms, overall operative time, length of hospital stay, and frequency of postoperative/procedural morbidity were recorded and studied. Left hemihepatectomy (left lateral segmentectomy) was performed under general anesthesia with the patient in the supine position. A reversed L-shaped incision was made. During the left hemihepatectomy, the falciform ligament, left triangular ligament, left coronary ligament, and hepatogastric ligament

were sequentially transected to mobilize the left lobe. The left hepatic artery and left portal vein were individually dissected, ligated, and divided. The main trunk of the left hepatic vein was identified and ligated, and the left hepatic bile duct was interrupted and labeled. The hepatic parenchyma was transected along a proposed division line. Major vessels and bile ducts were securely clipped during the process. For the left lateral segmentectomy, the left lobe was dissected in the same method. The second hepatic hilum was exposed, and the left hepatic vein was temporarily disrupted. The liver parenchymal tissues were dissected approximately 2 cm along the falciform ligament to identify the hepatic pedicle of the left lateral segment. Then, the orifice of the transected LHD was identified or clipped at the stump.

2.2. Methods

Bile duct exploration was performed upon the confirmation of gallstones by choledochoscopy (Olympus, Tokyo, Japan). Stones were removed using a retrieval basket, if applicable, followed by repeated bile duct flushing. T-tubes were placed in the following situations: removal of impact stone, large CBD stones, excessive right-sided hepatolithiasis, suspected residual stones, and undilated CBD (diameter <8 mm).

The CBD approach: after identifying the CBD via needle aspiration of bile from the duct, the common bile duct was exposed. A longitudinal choledochotomy was performed with curved scissors in the supraduodenal part of the CBD. After all the stones were cleared, the common bile duct was closed with interrupted sutures using 4-0 Vicryl with or without T-tube placement.

The LHD approach: following liver dissection, the LHD stump was dilated and retracted using sutures. After all the stones were extracted, the LHD orifice was securely ligated.

2.3. Postoperative care and follow-up

All patients received routine care and resumed oral food intake on the following day after surgery. The peritoneal drain was removed within 96 hours if no biliary leaks were observed. After confirming the absence of residual gallstones, the T-tube was removed 3 weeks after the operation during an outpatient visit. Postoperative ultrasonography and liver function tests were performed on the patients every 3 months or more frequently if any symptoms were present.

2.4. Statistical analysis

All quantitative data were expressed as the mean±standard deviation. Two-tailed unpaired Student's *t* test, χ^2 test, and/or Fisher's exact probability test were used to assess statistical significance of differences. $P<.05$ was considered to be statistically significant. All statistical calculations were performed using SPSS Software (version 19.0).

3. Results

The 2 groups were comparable in sex, age, previous history, hepatobiliary symptoms, gallstone comorbidities, biliary operation history, and the American Society of Anesthesiologists score ($P>.05$, Table 1). Intraoperative bile duct exploration was completed in the 2 groups via the assigned approach. There were no residual stones observed in the 2 groups. Ten patients in the CBD group underwent T-tube placement, whereas no patients in

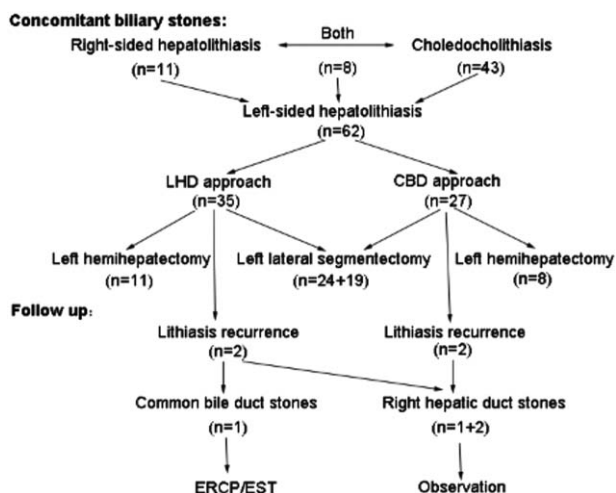


Figure 1. Flow chart of patient enrollment and treatment.

Table 1

Baseline characteristics of left-sided hepatolithiasis patients (n = 62) undergoing bile duct exploration via the left hepatic duct orifice or the common bile duct.

	CBD group (n = 27)	LHD group (n = 35)	P value
Age, years	57.6 ± 11.6	61.2 ± 10.0	.210
Gender (n)			.380
Female	19	28	
Male	8	7	
ASA score	1.7 ± 0.6	1.6 ± 0.6	.815
Hepatobiliary symptoms (n)			
Pancreatitis	4	6	.805
Jaundice	3	5	.712
Biliary symptoms	20	27	.780
Concomitant biliary stones (n)			
Choledocholithiasis	18	25	.687
Right-sided hepatolithiasis	6	5	.417
Both	3	5	.712
Biliary operation history (n)			
Choledocholithotomy	22	28	.884
Bile enteric anastomosis	3	5	.712
Uncertain	2	2	.788
Times of previous operations (n)			.879
≤ 3	19	24	
> 3	8	11	

CBD = common bile duct, LHD = left hepatic duct

the LHD group required T-tube placement. In the CBD group, 2 patients experienced duodenum injury, 1 patient experienced common bile duct injury, and 1 patient experienced portal vein injury, whereas no patients in the LHD group suffered these intraoperative complications. Postoperative bile leakage was not observed in the LHD group but was observed in 4 patients (4 of 27) in the CBD group ($P < .05$), which was resolved with the placed peritoneal drain. The LHD group had a significantly shorter operative time than the CBD group (134.5 ± 17.6 minutes vs 159.1 ± 39.8 minutes; $P < .05$). The postoperative duration of hospitalization was significantly shorter in the LHD group than in the CBD group (8.0 ± 1.2 days vs 9.5 ± 2.9 days; $P < .05$) (Table 2).

Table 2

Surgical outcomes of patients who were successfully treated for left-sided hepatolithiasis (n = 62) with bile duct exploration via the left hepatic duct orifice or the common bile duct.

	CBD group (n = 27)	LHD group (n = 35)	P value
Hepatectomy (n)			.879
Left hemihepatectomy	8	11	
Left lateral segmentectomy	19	24	
Mean operative time, minutes	159.1 ± 39.8	134.5 ± 17.6	.002
Postoperative stay, days	9.5 ± 2.9	8.0 ± 1.2	.007
Intra-operative complication (n)			.019
Duodenum injury	2	0	
Portal vein injury	1	0	
Common bile duct injury	1	0	
T-tube placement (n)	10	0	<.001
Bile leaks (n)	4	0	.019
Residual stones (n)	0	0	–

CBD = common bile duct, LHD = left hepatic duct.

During a mean follow-up period of 18 months, there were 4 (5.6%) patients with intrahepatic or extrahepatic lithiasis recurrence. Postoperative ultrasonography confirmed that 1 patient had cholangitis and 3 had an impaction of small stones at the right hepatic duct. These clinical outcomes are summarized in Figure 1.

4. Discussion

Patients with hepatolithiasis usually have concomitant extrahepatic gallstones. Therefore, bile duct exploration and stone extraction are required in these cases. In our country, the patients share some of the following common characteristics: (1) the patients have undergone several biliary operations before they accept hepatectomy; (2) some patients could not provide useful information about their previous operations. It is worth noting that previous operations and unknown surgical procedures may make CBD dissection more difficult. Conventional choledochotomy requires dissection of the CBD; however, choledochotomy can easily be completed via the LHD stump.

We prefer cholangioscopy via the LHD orifice over conventional choledochotomy in LSH patients for the following reasons:

(1) Patients with bile duct stones usually require 2 or more operations due to their high rate of recurrence. For recurrent stones, endoscopic retrograde cholangiopancreatography/endoscopic sphincterotomy (ERCP/EST) has been shown to be a safe and effective treatment.^[8] Unfortunately, a history of operations was a potential predictor of failure to achieve endoscopic CBD clearance.^[9,10] If EST fails, choledocholithotomy is an acceptable salvage procedure.^[11] Adhesions around the common bile duct occur after each choledochotomy, which may cause difficulties in CBD dissection during subsequent operations.

(2) Biliary leak and residual stones constitute the predominant postoperative morbidities of biliary stones.^[12,13] In our patients, biliary leak occurred more frequently in the CBD group than the LHD group. Although all of the biliary leaks resolved within a few postoperative days, this complication prolonged the length of hospitalization. In our opinion, the LHD stump could be enlarged to 1 to 2 cm in diameter by forceful dilatation, which enabled us to explore the right hepatic duct and the CBD without a sharp angle. Because few blind spots were present, the technique could easily be manipulated.^[7,14,15] In contrast to ERCP, common bile duct exploration via the LHD orifice follows the direction of bile flow, which is basically an antegrade choledochoscopy. Cholangioscopy through the LHD has a lower chance of flushing out little gallstones into second- or third-order bile ducts compared to conventional choledochotomy. These little stones are the predominant sources of residual stones. Residual stones are rarely present, but the patients without a T-tube may require a repeated choledocholithotomy. It is worth noting that in a subset of intrahepatic gallstone patients presenting with an undilated CBD (diameter < 8 mm), the use of primary closure is not recommended because of the high risk for anastomotic stricture and subsequent complications.^[16] Furthermore, owing to the minimal interference with the common bile duct, biliary leak and the placement of a T-tube rarely occurred in patients undergoing bile exploration via the LHD orifice.

(3) Patients with a history of biliary operations may experience several intraoperative complications during dissection of the CBD.^[17] Adhesions form between the surfaces of the gallbladder bed, gallbladder triangle, greater omentum, duodenum, and transverse colon after biliary surgeries. During conventional choledochotomy, we have to address the adhesions before

dissecting the CBD, which may result in injuries to the duodenum and the transverse colon. Furthermore, the tissues around the CBD become tough, which increases the likelihood of injuring the common bile duct and the portal vein. Biliary operations preceding CBD dissection include choledocholithotomy and bile enteric anastomosis. Duodenum injuries during the dissection of the CBD are more common in patients with bile enteric anastomosis. For patients with an uncertain history of biliary surgery, we must anticipate the probable influence of biliary enteric anastomosis during CBD dissection. However, a choledochotomy can be easily completed using the LHD approach by dissecting the left portal vein and left hepatic artery near the left liver diaphragmatic surface. In our study, the LHD group had a significantly shorter operative time than the CBD group. In the CBD group, 2 patients suffered from duodenum injuries, 1 patient suffered from a common bile duct injury, and 1 patient suffered from a portal vein injury. We should pay more attention to the fact that all patients with intraoperative complications had undergone more than 3 biliary tract surgeries. However, such complications were avoided in patients with similar surgical histories using the LHD approach.

(4) Bile duct exploration through the LHD has some limitations. When there are strictured stumps, the cholangioscope cannot be easily guided into the CBD. Additionally, large-sized stones and impacted stones cannot be extracted through the stumps. Thus, we do not recommend the use of the LHD approach in cases of strictured LHD stumps or undilated LHD stumps with big stones because of the high risk of hepatic duct injuries and subsequent complications. Despite all this, it is beneficial to locate the common bile duct with biliary bougie assistance through the LHD orifice.

References

- [1] Kitagawa Y, Nimura Y, Hayakawa N, et al. Intrahepatic segmental bile duct patterns in hepatolithiasis: a comparative cholangiographic study between Taiwan and Japan. *J Hepatobiliary Pancreat Surg* 2003;10:377–81.
- [2] Hwang JH, Yoon YB, Kim YT, et al. Risk factors for recurrent cholangitis after initial hepatolithiasis treatment. *J Clin Gastroenterol* 2004;38:364–7.
- [3] Chen Z, Gong R, Luo Y, et al. Surgical procedures for hepatolithiasis. *Hepatogastroenterology* 2010;57:134–7.
- [4] Azuma T, Yoshikawa T, Araidai T, et al. The significance of hepatectomy for primary intrahepatic stones. *Surg Today* 1999;29:1004–10.
- [5] Chen DW, Tung-Ping Poon R, Liu CL, et al. Immediate and long-term outcomes of hepatectomy for hepatolithiasis. *Surgery* 2004;135:386–93.
- [6] Hu MG, Zhao GD, Ouyang CG, et al. Lithotomy using cholangioscopy via the left hepatic duct orifice versus the common bile duct in laparoscopic treatment of left-sided hepatolithiasis: a comparative study. *J Laparoendosc Adv Surg Tech A* 2013;23:332–8.
- [7] Zhang K, Zhang SG, Jiang Y, et al. Laparoscopic hepatic left lateral lobectomy combined with fiber choledochoscopic exploration of the common bile duct and traditional open operation. *World J Gastroenterol* 2008;14:1133–6.
- [8] Sugiyama M, Suzuki Y, Abe N, et al. Endoscopic retreatment of recurrent hepatolithiasis after sphincterotomy. *Gut* 2004;53:1856–9.
- [9] Karaliotas C, Sgourakis G, Goumas C, et al. Laparoscopic common bile duct exploration after failed endoscopic stone extraction. *Surg Endosc* 2008;22:1826–31.
- [10] Kim HJ, Choi HS, Park JH, et al. Factors influencing the technical difficulty of endoscopic clearance of bile duct stones. *Gastrointest Endosc* 2007;66:1154–60.
- [11] Shelat VG, Chan CY, Liao KH. Laparoscopic exploration can salvage failed endoscopic bile duct stone extraction. *Singapore Med J* 2012;53:313–7.
- [12] Mattila A, Luhtala J, Mrena J, et al. An audit of short and long-term outcomes after laparoscopic removal of common bile duct stones in Finland. *Surg Endosc* 2014;28:3451–7.
- [13] Naumowicz E, Bialecki J, Kolomecki K. Results of treatment of patients with gallstone disease and ductal calculi by single-stage laparoscopic cholecystectomy and bile duct exploration. *Wideochir Inne Tech Maloinwazyjne* 2014;9:179–89.
- [14] Sun WB, Han BL, Cai JX. The surgical treatment of isolated left-sided hepatolithiasis: a 22-year experience. *Surgery* 2012;127:493–7.
- [15] Hwang S, Lee SG, Kim MH, et al. Intraoperative biliary exploration through the left hepatic duct orifice during left hepatectomy in patients with left-sided hepatolithiasis. *Langenbecks Arch Surg* 2008;393:383–9.
- [16] Zhou Y, Wu XD, Fan RG, et al. Laparoscopic common bile duct exploration and primary closure of choledochotomy after failed endoscopic sphincterotomy. *Int J Surg* 2014;12:645–8.
- [17] Strik C, Stommel MW, Schipper LJ, et al. Risk factors for future repeat abdominal surgery. *Langenbecks Arch Surg* 2016;401:829–37.