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Original Article

Application of combined rigid choledochoscope and accurate positioning method in the adjuvant treatment of bile duct stones

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Abstract: To explore the clinical effect of percutaneous transhepatic cholangioscopic lithotomy (PTCSL) combined with rigid choledochoscope and accurate positioning in the treatment of calculus of bile duct. This study retrospectively reviewed 162 patients with hepatolithiasis at the First Affiliated Hospital of Guangzhou Medical University between 2001 and 2013 were assigned to hard lens group or traditional PTCSL group. Compared with the traditional PTCSL, PTCSL with rigid choledochoscope can shorten the interval time which limit the PTCSL application. The operation time (45 vs 78, P=0.003), the number of operation (1.62 vs 1.97, P=0.031), and blood loss (37.8 vs 55.1, P=0.022) were better in hard lens group while the stone residual and complication had no significant differences. Rigid choledochoscope is a safe, minimally invasive and effective method in the treatment of bile duct stones. Accurate positioning method can effectively shorten operation process time.

Keywords: Rigid choledochoscope, sheath, accurate positioning, PTCSL, bile duct stone

Introduction

Hepatolithiasis represents stones in the intrahepatic biliary tree which is most common in East Asia [1]. It can cause several clinical symptoms such as biliary colic and jaundice, and some may be lethal. Stone removal is the primary method to deal with the clinical symptoms. Among the various methods for stone removal, the standard treatments are endoscopic sphincterotomy (EST) and stone extraction, while mechanical lithotripsy (ML) is a second line therapy choice for difficult cases [2]. However, there is still 5-10% of stones will be remained and 23-34% will relapse [3]. Furthermore, patients with poor surgical risk will also be difficult to treat.

Percutaneous transhepatic cholangioscopic lithotomy (PTCSL) is one of the alternative methods when surgical resection is not suitable as a result of the patient's condition or the presence of stones in multiple segments. The PTCSL procedure is less invasive than hepatectomy and able to conserve a greater degree of liver mass. Compared with other new methods, the main advantages of PTCSL include easy approach to the bile duct and stones management [3]. Patients with previous biliary surgery or stone distribution in multiple segments, and those who refuse surgery are suggested to be the appropriate candidates for PTCSL [4]. On the other hand, however, 2-3 weeks is needed for the establishment of operation channel in traditional PTCSL. And stones can only be cleared by many times is another drawback of this procedure. In addition, a PTBD tube must be kept in place throughout the treatment period. Therefore, this technique is invasive, time-consuming, and painful [5].

Here we report the use of a new rigid choledochoscope and accurate positioning method instead of traditional fiber choledochoscope to improve the PTCSL procedure and evaluate its effect on patients.

Materials and methods

Patients

During the year between 2001 and 2013, PTCSL was performed for 162 patients with hepatolithiasis. Hepatolithiasis was diagnosed by abdominal ultrasonography, computed tomography, endoscopic retrograde cholangiopancreatography, and magnetic resonance cholangiopancreatography. The cause of PTCSL performance was recurrence stones, after abdomen surgery, or intolerance to hepatectomy.

Ethics statement

The study protocol and amendments were approved by institutional ethics committee of the First Affiliated Hospital of Guangzhou Medical University.

Grouping

162 patients were grouped into PTCSL with rigid choledochoscope group and traditional PTCSL group, respectively. Specially, the criteria were as follows:

Indication for PTCSL with rigid choledochoscope: patients with complicated hepatic calculus older than 18 years old; liver function was classified into Child A or B; patients can tolerate to surgery treatment and agreed to receive PTCSL with rigid choledochoscope; patients with recurrence stone after Roux-en-Y or biliary tract surgery; patients with local hepatic calculus; patients with hepatic duct tumor combined with calculi; patients elderly, high-risk, or refuse to laparotomy.

Indication for traditional PTCSL: patients with complicated hepatic calculus; liver function was classified into Child A or B; patients can tolerate to surgery treatment; patients with obstructive jaundice; patients with bile duct benign stricture.

Exclusive criteria: liver function was classified into Child C; liver segment or lobe appeared atrophy or fibrosis; patients with heart, liver, lung, or renal dysfunction; non-complicated hepatolith; combined with cholangiocarcinoma; patients refuse to surgery treatment.

Methods

PTCSL was managed including two procedures. In the first procedure, a tract between the skin and the intrahepatic duct was made by percutaneous transhepatic biliary drainage (PTBD) and dilated for a cholangioscope passage. During the second procedure, a cholangioscope was inserted in order to facilitate the fragmentation and stones removing.

Prior to the PTBD procedure, patients were administered intravenously with systemic antibiotics and premedicated with meperidine, midazolam, and local lidocaine. After puncturing the bile duct with an ultrasound-guided needle and introducing a guidewire into the bile duct through the puncture needle, an 8.5F PTBD drainage tube (Dawson-Mueller Drainage catheter; Cook, Bloomington, IN, USA) was inserted through the guide wire. Two days after PTBD, the tract was dilated to 16 or 18F in one or two session using a dilator (Amplatz Renal Dilator Set; Cook) within 1 week except in the patients with the symptom of persistent cholangitis. Approximately 10 to 14 days after the final dilatation, a cholangioscope (CYF-VA2; Olympus Optical Co., Tokyo, Japan) was introduced safely into the biliary tree.

PTCSL was performed under the pain control and the cholangitis prevention. PTCSL was applied at 2- or 3-day intervals after reinsertion of a PTBD drainage tube once the repeated treatment was required. PTBD drainage tube was removed if no additional symptoms occurred during the 1- or 2- day period of PTBD tube clamping after complete stone removal.

For the PTCSL combined with rigid cholangioscope, the PTCSL procedure started in the same time with PTBD without additional intervals. Patients received preoperative CT scan to get the anatomical distribution information of stones, and then color doppler ultrasound was performed for intrahepatic vessels location which could help keep away from vessels during puncture. PTCSL was performed general anesthesia. After successfully percutaneous liver puncture and guide wire placing, fistula was expanded by 8F directly till 16 or 18F. 16 or 18F matching sheath pipe was sleeved to the dilator and reached the target bile ducts, and then the dilator was pulled out. Rigid choledo-

Table 1. Baseline clinical characteristics of the two groups

	PTCSL with rigid choledochoscope	Traditional PTCSL	
	n	n	*P*
	99	63	
Sex			0.873
Male	47	31	
Female	52	32	
Age (mean ± sd)	54.45±13.44	58.43±15.33	0.094
Past history			
Hypertension	5	15	0.001
Diabetes	5	2	0.707
Liver fluke	2	2	0.643
Biliary tract ascariasis	1	0	1
Biliary cirrhosis	3	1	1
Biliary tract infection	7	4	1
General surgery history			
Abdomen	29	21	0.605
Cholecystectomy	64	35	0.253
Exploratory choledochotomy	43	27	1
Hepatolobectomy	12	11	0.363
Roux en Y	8	18	0.001
Blood test			
TBIL (mmol/L)	78.74±68.19	77.72±90.31	0.874
DBIL (mmol/L)	40.46±33.21	32.89±55.04	0.521
ALT (U/L)	80.6±123.4	89.06±123.16	0.673
AST (U/L)	99.05±254.29	133.16±296.79	0.664
ALB (U/L)	39.22±38.54	42.54±49.74	0.654
γGGT (U/L)	328.37±565.06	306.7±276.15	0.757
ALP (U/L)	200.87±149.78	275.88±262.42	0.183
HGB (g/L)	115.97±22.13	127.95±112.88	0.412
PT (s)	14.26±9.71	13.65±2.49	0.567
APTT (s)	38.12±10.91	38.93±6.2	0.562
HCV (+)	0	1	0.389
HBsAg (+)	6	5	0.752
ASA grade			0.47
II	34	19	
III	53	32	
IV	12	12	
CT scan stones			
S1 segment	41	19	0.182
S2 segment	46	16	0.008
S3 segment	15	7	0.639
S4 segment	11	7	1
S5 segment	9	7	0.788
S6 segment	14	9	1
S7 segment	17	9	0.667
S8 segment	16	5	0.155
B ultrasonic examine stones			
Left lobe	52	30	0.629

choscope was used to rubble and take stone. If the gravel diameter was less than the sheath pipe's, a mesh basket or lithotomy forceps can be used. If stone diameter was large, breaking up the stone with crusher and "rushing" out through sheath pipe. If stenosis existed in the bile duct, expand it with biliary balloon expander. If obvious fibroplasia can be found in the stenosis, inject mannitol at first and cut the stenosis before expansion. If the narrow section has the possibility of restenosis after expansion, a 14F drainage tube may be retained and will support the catheter indwelling 8~11 months.

Blood loss evaluation

Calculation of blood loss after surgery was based on hemoglobin (Hb) balance (6). Blood Hb concentration was measured preoperatively. The blood loss was then estimated according to the formula:

Blood loss = Total drainage (ml) × Hb concentration in drainage (g/L)/Hb concentration preoperatively (g/L).

Statistical analysis

Pearson χ^2 test (when no cell of a contingency table has expected count less than five) or Fisher's exact tests (when any cell of a contingency table has expected count less than five) was used to assess the association between two categorical variables with SPSS for Windows (Version 11.0, Chicago, IL).

Right lobe	53	25	0.107
Bilateral	10	16	0.015
Common bile duct	61	23	0.002
Hepatic lobe atrophy			
Left lobe	1	4	0.079
Right lobe	2	1	1
Bilateral lobes	3	0	0.279

Based on the CT scan, the stones distributed evenly in the eight hepatic segments except the second. While on the B-ultrasonic examine, patients received traditional PTCSL appeared more bilateral stones (P= 0.015) and less choledocholithiasis (P=0.002). Furthermore, though rarely appeared, hepatic lobe atrophy in the two groups had no significant differences.

Table 2. Comparison of operation procedure

	PTCSL with rigid choledochoscope	Traditional PTCSL	
	n	n	*P*
Operative time (min)	45.1±98.8	78.2±82.8	0.003
Operation frequency	1.62±0.9	1.97±0.13	0.025
Intraoperative blood loss (ml)	37.8±24.2	55.1±31.9	0.022
Blood transfusion times	2	6	0.076

Operation process comparison (time, hospital stays, blooding)

P values of less than 0.05 were considered significant.

Results

Basic characteristics

We recruited 162 hepatolithiasis patients for PTCSL procedure. Baseline clinical characteristics are shown in **Table 1**. There were 78 men and 84 women aged between 21 and 94 years (mean, 56 years). Of the patients, 99 were treated by PTCSL with rigid choledochoscope and accurate positioning, and 63 underwent traditional PTCSL. For the past history affected hepatolithiasis formation and treatment decisions, only more patients with hypertension affiliated to the traditional group (P=0.001), while there was no significant differences in diabetes, liver fluke, biliary tract ascariasis, biliary cirrhosis, and biliary tract infection history between the two groups. The difference of general surgery history between the two groups was lack of significance, while in detail traditional PTCSL group patients got more Roux en Y bile intestinal anastomosis (P=0.001). Patients in two groups were all in ASA grade II-IV for anesthesia evaluation, and the distribution was similar in the two groups (P=0.47). The liver function and coagulation profile in the two groups revealed no significant differences. Also, the HBsAg and HCV only appeared in 11 and 1 patient, respectively, and distributed to the two groups equally.

The operative time in the PTCSL with rigid choledochoscope varied from 15-285 minutes and in the traditional PTCSL group varied from 16-255 minutes. The mean operative time used in the PTCSL with rigid choledochoscope group was much shorter than the traditional group (45.1 vs 78.2 minutes, P=0.003). For the average operative times of each patient, the PTCSL with rigid choledochoscope group was smaller (1.62 vs 1.97, P=0.031) (**Table 2**).

The intraoperatve blood loss in the PTCSL with rigid choledochoscope was 37.8 mL which was less than the traditional PTCSL group as 55.1 mL (P=0.022). Totally 8 patients received intraoperative blood transfusion and only 2 appeared in the PTCSL with rigid choledochoscope group.

Stone immediate & final remnant and recurrence comparison

17 patients in the PTCSL with rigid choledochoscope group after the first operation presented immediate stone residual compared with 14 in the traditional PTCSL group, and no significant difference was found (P=0.539). Furthermore, the final stone residual rate detected by the ultrasonography or computed tomography during the 3 month follow-up was similar in the two groups (P=1.000). Also, the stone recurrence rate in the mean 32 months follow-up had no significant difference between the two groups (P=0.744). No patients died in the perioperative period (**Table 3**).

Table 3. Comparison of stone residual

	PTCSL with rigid choledochoscope	Traditional PTCSL	
	n	n	*P*
Immediate stone residual	17	14	0.539
Final stone residual	32	20	1
Stone recurrence	38	26	0.744

Table 4. Comparison of complications

	PTCSL with rigid choledochoscope	Traditional PTCSL	
	n	n	*P*
Incision infection	0	1	0.389
Pleural effusion	1	1	1
AOSC	6	3	1
Postoperative bleeding	0	2	0.150

Short complication

The short-term complications occurrence rate including incision infection, pleural effusion, and postoperative bleeding was low and similar in two groups (P>0.05). Acute obstructive suppurative cholangitis (AOSC) appeared in 6 and 3 patients in the two groups, respectively. And they all received further treatment for definitive surgery after liver function, coagulation, blood pressure, temperature, and mind recover. No patients presented pulmonary infection, intestinal fistula, bile leakage or ascites. During the mean 32 months follow-up, no patients appeared intrahepatic biliary stricture or cholangitis as long-term complications (**Table 4**).

Discussion

Traditionally, hepatectomy seemed to be the most definitive approach since it solves stone and biliary stricture simultaneously, and reduces the risk of intrahepatic stone recurrence [7]. However, surgery sometimes may not be an option in patients at high surgical risk, who refuse surgery, those that have undergone biliary surgery, or when stones are distributed in multiple segments [8]. Non-surgical approaches for hepatolithiasis contain endoscopic and/or radiological procedures. It is considered relatively safe for the endoscopic treatment of hepatolithiasis [9], but further access is limited by ductal angulation, strictures, and the degree of stone impaction [7]. Almost 40% of hepatolithiasis cases have intrahepatic bile duct strictures, which make stone extraction difficult [10]. Furthermore, bile duct strictures impede the definitive removal of sclerotic damage from intrahepatic biliary ducts, and this predisposes the recurrence of septic complications and the need for repeated treatments [11].

PTCSL is an easy and useful technique to remove hepatolithiasis because of its easy approach and direct visualization of bile duct stones. In the past, Bonnel et al. reported a series of 50 patients with intrahepatic and common bile duct (CBD) stones that received PTCS-EHL reached 100% fragmentation rate and 92% final stone clearance rate [12]. However, the complication and mortality rates were really high at 22% and 8%, respectively. Therefore, current and other studies [13, 14] definitely demonstrate that PTCSL is one of the safest and best tolerated among various options. This can be attributed to instruments and technology improvements such as small caliber cholangioscope design, EHL, interventional developments, and improvements in balloon dilator design. Compared with other methods, another advantage of PTCSL is the ability to execute precise examination of the intra or extrahepatic bile duct. Though this procedure has been generally restricted to cases failed in conventional endoscopic procedure, PTCSL is generally safe and well tolerated by patients. Despite its long procedure time, PTCSL especially fits for patients with old age or in poor condition.

The major shortage of PTCSL are the need for invasive procedures and additional time for dilatation and maturation of the PTBD tract [15]. Traditionally, PTCSL involves the use of a flexible choledochoscope, while the flexible choledochoscope has inherent problems. It is fragile and has a narrow working channel, through which instruments like graspers and pneumatic lithotripsy probes cannot be passed.

Rigid cholangioscope is a type of nephroscope with a working channel. Several studies have pointed out numerous problems and shortcomings when using rigid scope in the CBD. For example, dichotomy incision tear may lead to

inadvertent enlargement in the incision which end sutures had been advised. Without duodenal kocherization, it was unable to see the proximal CBD and common hepatic duct, and difficult to visualize the terminal end of the CBD [16]. However, in the operation process, the rigid choledochoscope can show as proximal as the hepatic ducts when introduced across the second 10-mm port. When the rigid choledochoscope is introduced through the 5-mm epigastric port, it can be applied to present as distal as the duodenum through the ampulla of Vater even without any kocherization of the duodenum. For visualizing the distal CBD, the surgeon must align the long axis of the rigid choledochoscope with that of the CBD, and for visualizing the proximal CBD and the carina, the rigid choledochoscope has to be directed proximally with delicacy, as any coarse movement can cause trauma to the CBD, leading to later stricture formation. In addition mismanagement of the rigid choledochoscope can enlarge the choledochotomy significantly.

Before the operation, we used accurate positioning method to fix the exact location of the stones, which may guide us the puncture procedure. Combined with the rigid choledochoscope technique, the operation time was large shorter compared with the traditional PTCSL group. Postoperative complications rate has been reported as 4.75%-20% [17-21], compared with 7.1% in our PTCSL with rigid choledochoscope series. All of the complications were reversible and responded to conservative treatment. Furthermore, in our mean 32 months follow-up, no long term complications such as intrahepatic biliary stricture or cholangitis were observed.

Thus, the rigid choledochoscope can be considered an important adjunct in the medical equipment of the laparoscopic biliary surgeon. With the advantage of being robust and having a large working channel for the passage of graspers and pneumatic lithotripsy probes, the rigid choledochoscope can be used to clear a number of large hard impacted stones.

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Disclosure of conflict of interest

None.

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