ORIGINAL ARTICLE

A new technique of percutaneous transhepatic rigid cholangioscopic lithotripsy applied in the treatment complicated hepatolithiasis

Ping Wang[1], Haisu Tao[2], Beiwang Sun[1], Kun Li[1], Canhua Zhu[1], Zhaoshan Fang[3]

Wang P, Tao H, Sun B, et al. New technique of percutaneous transhepatic rigid cholangioscopic lithotripsy applied in the treatment of complicated hepatolithiasis. J Hepato Gastroenterol 2018;2(1):4-9.

BACKGROUND: The aim of this retrospective study was to compare the outcomes of PTCSL-based-on-PTOBF (percutaneous transhepatic one-step biliary fistulation) with traditional PTCSL in the treatment of complicated hepatolithiasis.

STUDY DESIGN: From July 2008 to March 2016, 189 patients with complicated hepatolithiasis received surgical treatment in our department. Among these cases, a total of 103 patients received PTCSL-based-on-PTOBF (Group A); the remaining 86 received traditional PTCSL (Group B).

RESULTS: Compared with Group B, Group A was charactered by a significantly shorter length in operation time (81.5 ± 27.0 VS 119.2 ± 42.2; p=0.000), Hospital stay (13.5 ± 3.6 d vs 18.1 ± 5.6 d; p=0.032) and Postoperative hospital stay (9.5 ± 3.4 d vs 10.1 ± 5.4 d; p=0.026). Intermediate residual stone (9 in group A and 16 in group B; p=0.046) and Final residual stone (12 in group A and 22 in group B; p=0.013) in Group A were also lower than those in Group B. Besides, the total of bilirubin (24.7 ± 17.0)

mmol/L vs 31.7 ± 22.2 mmol/L; p=0.027) and ALT (103.5 ± 61.0 U/L vs 120.2 ± 76.7 U/L; p=0.042) of Group A were obviously lower. While the two groups had no differences in intraoperative blood transfusion, intraoperative blood loss and postoperative complications.

CONCLUSION: Compared with traditional PTCSL, PTCSL-based-on-PTOBF was more efficient and effective in the treatment of complicated hepatolithiasis.

Key Words: *Hepatolithiasis; Percutaneous Transhepatic Rigid Cholangioscopic Lithotripsy*

Hepatolithiasis, a highly prevalent disease in East Asian countries, is becoming increasingly common in Western populations (1). For the past years, hepatic resection has been the most effective treatment for intrahepatic stones because resection removes not only the stones but also many of the associated pathologic changes including bile duct strictures (2-4). However, surgery is not an option for patients who are poor surgical risks or who refuse surgery and in those with previous biliary surgery or stones distributed in multiple segments (5,6). With the advent of endoscopic and radiologic intervention, PTCSL for hepatolithias has become a well-established mode of treatment (7). As we all known, compared with traditional surgery, PTCSL have its advantages for less trauma, faster recovery and its repeatability. PTCSL not only could remove the stones, but also was available for the treatment of bile duct stenosis with a variety of methods to reduce the recurrence rate of cholecystolithiasis (8,9). Nevertheless, the traditional PTCSL also had disadvantages for multiple operations and long treatment cycle (10). In the procedures of traditional PTCSL, the patient must receive percutaneous transhepatic cholangial drainage (PTCD), and in three days would receive cholangiography to give a careful observation of intrahepatic and extrahepatic biliary tract to confirm the location of stenosis and the distribution of stones. Then the patient would keep staging expansion of fistula with two times one week and every time it would add another 2 to 3FR (11). Approximately three or four weeks later, the fistula already could hold an 16~18 FR tube by expansion, and at this situation the fistula wall was fragile and extremely close to intrahepatic vascular. As a result, that the tube need stay in the fistula for one more week to ensure the fistula wall was relatively solid for choledochoscope surgery (12-14). With the aid of the new method, percutaneous transhepatic one-step biliary fistulation (PTOBF), the disadvantages of the traditional PTCSL could be effectively solved. In the PTCSL based on PTOBF, the sinus was expanded to suitable size (16-18FR) immediately as soon as a percutaneous biliary puncture (PTC) was successfully accomplished. Then, the protective sheath was used to ensure choledochoscope surgery could be immediately applied without waiting for the complete recovery of sinus tissue, which would not only cut down the risk of surgical bleeding and other risks, but also greatly shorten the duration of treatment. What's more, it could also reduce the times of operations and the cost. The purpose of this retrospective study was to evaluate the effect of using percutaneous transhepatic one-step biliary fistulation (PTOBF) and combining rigid choledochoscope technology in the treatment of complicated hepatic chololithiasis.

METHODS

Ethics statement

This retrospective study and supervised procedures were running with the permission of The Ethics Committee of the First Affiliated Hospital of Guangzhou Medical University (Guangzhou province, China).

Patients

All the recorded patients with being retrospectively analyzed were diagnosed with hepatolithiasis and accepted treatment with PTCSL from July 2008 to March 2016 In the Department of Hepatobiliary Surgery of the First Affiliated Hospital of Guangzhou Medical University.

All the chosen patients with percutaneous transhepatic rigid cholangioscopic lithotripsy must meet the following criterions.

(1) Patients were diagnosed with complicated hepatolithiasis;

(2) Patients must be over 16-year-old;

(3) Patients' preoperative liver function must reach Child-Pugh A or B grades, or C grade, and without any coagulation disorders;

(4) During the operation, patients' sphincter of Oddis function was certified normal, and there was no need for cholangioenterostomy;

(5) None of the patients received liver resection. Among those who should had received liver resection, some were confirmed intolerable to liver resection preoperatively or intraoperatively, while the others refused it.

[1]Department of Hepatobiliary Surgery, Hospital of Guangzhou Medical University, Guangdong Province, P.R China, [2]Department of Surgical Oncology, Xinyang Central Hospital, P.R China, [3]Department of Hepatobiliary Surgery, The First People's Hospital of Nanning, P.R China

Correspondence: Dr. Ping Wang, MD, Department of Hepatobiliary Surgery, Hospital of Guangzhou Medical University, Guangdong Province, P.R China 510282, Telephone +86 20 3429 4116, email: wangping_dr@126.com

Received: January 2, 2018, Accepted: January 20, 2018, Published: February 24, 2018

All the patients must know all the following details, such as treatments process, risks and complications. The patients were divided into two groups based on whether they received treatment with PTOBF or not. Finally 103 patients with PTOBF were into Group A, and another 86 patients with traditional PTCSL were Group B. In order to ensure the quality and safety of operation, all the surgical treatment and postoperative management were operated by the same team.

The procedure of PTCSL based on PTOBF (Figure 1)

1. **Patients' imaging date collection:** Locations of calculi and biliary strictures were evaluated preoperatively. Preoperative evaluations included ultrasonography, CT, endoscopic retrograde cholangiopancreatography (ERCP) or magnetic resonance cholangiography (MRCP). MRCP, CT and ultrasonography would cover all patients, while other aspects such as 3D reconstruction and ERCP would depended on patients' desire.

2. **Preoperative planning:** Every complicated hepatolithiasis patient who met all the above criterions would receive a preoperative planning that was designed according to the imaging date that could show us the size and location of the stones, the adjacent relationship with important vessels and the details of biliary strictures.

3. **Puncturing the biliary tract guided by intraoperative ultrasonography:** According to the preoperative planning, the location and direction of puncture were confirmed and marked. Puncturing the biliary tract would be guided by intraoperative ultrasonography, and in order to confirm the puncture point correct, it was necessary to combine operative cholangiography through the biliary drainage catheter in the C-arm x-ray machine.

4. **Establishing a channel for rigid cholangioscope:** The zebra guidewire would be placed into the target bile duct where a successful punturing was operated. With the guidance of the zebra guidewire, the biliary expanders from 8 to 16 Fr were used to expand the sinus step by step and finally could hold a 16 or 18 Fr protective sheath. At this time, a fistulous channel from outside to the intrahepatic duct was established. Through the protective sheath, operational manipulations could be applied with rigid cholangioscope (Figure 2).

5. **Exploring the biliary tract by rigid choledochoscope**: Various methods could be available for rigid choledochoscope, of which pneumatic ballistic lithotripsy was a common method to large calculus. Lithotripsy could be immediately applied as soon as the calculus was found, then the shattered calculi could be flushed out with physiological saline by "wash and suction" function small stones can be directly flushed out with the washing function of the rigid choledochoscope and protective sheath. The remaining larger stones could also be taken out with a basket (NTSE- 045065-UDH; Cook Medical) or a clamp (Ureteral Grasping Forceps; Richard Wolf Medical Instruments Corporation, Vernon Hills, IL). All operational manipulations were performed within the protective sheath and avoided the direct contact with biliary ducts (15).

Perioperative and operative data

Based on the analysis of preoperative clinical data, it was identified for surgical variables, postoperative clinical outcomes and independent variables. The outcomes of the 2 groups were also under comparison.

Preoperative clinical data included Sex, Surgical history, HGB, TBIL, ALT, AST, Platelets, ALB, Prothrombin time, Biliary stricture, Location of stone, and Liver atrophy.

Surgical variables included operative time, intraoperative blood transfusion, intraoperative blood loss, percutaneous location, intermediate residual stone, final residual stone, perioperative mortality.

Postoperative clinical outcomes were comprised of hospital stay, postoperative hospital stay, residual intrahepatic duct stricture, postoperative complications, and postoperative examination index.

Statistical analysis

Based on the statistical analysis under SPSS 21.0 for Windows, Continuous data was presented as average standard deviation and categorical variables as n (%). categorical variables were compared with the chi-square test or Fisher's exact test, and continuous variables were compared with the Student's t-test. In all cases, statistical significance was defined as $p<0.05$.

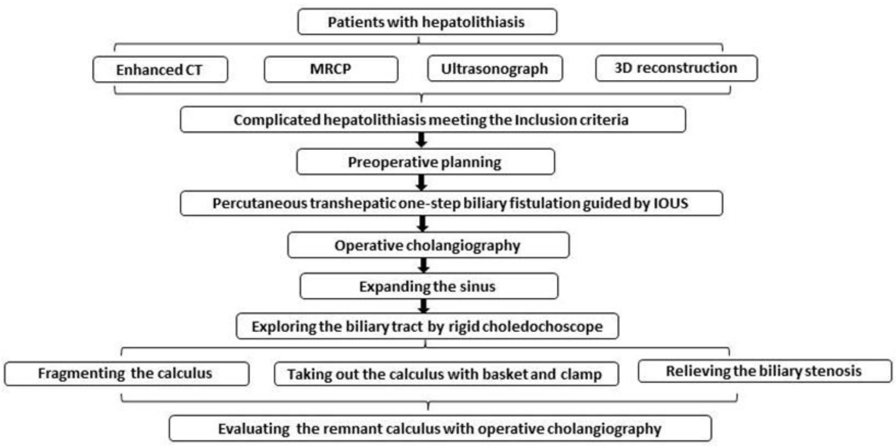


Figure 1) *The procedure of PTCSL based on PTOBF*

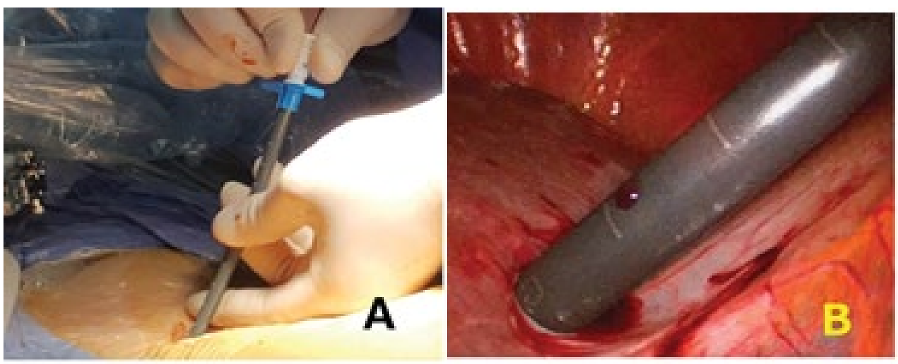


Figure 2) *The surgical entry established by the protective. A. The appearance of protective sheath observed from outside. B. The surgical entry established by the protective sheath observed by laparoscopy*

RESULTS

Patient demographics, clinical characteristics, and preoperative medical imaging outcomes were shown as Table 1.

Although the 2 groups shared the similar age, sex distributions and preoperative laboratory features, there were some significant differences in the number of patients with biliary strictures of S6 (14 in group A and 4 in group B; p=0.037) and other than that, there was no any other statistical differences in other liver segments of stricture and location of stone.

Intraoperative data

As shown in Table 2 about Intraoperative data of the 2 groups, it was obvious that the operative time of Group A was less than that of Group B (81.5 ± 27.0 VS 119.2 ± 42.2; p=0.000). Intermediate residual stone (9 in group A and 16 in group B; p=0.046) and Final residual stone (12 in group A and 22 in group B; p=0.013) in Group A were also lower than those in Group B.

Other than that, there were no significant differences in Intraoperative blood transfusion, Intraoperative blood loss, Percutaneous location and Perioperative mortality. Postoperative complications and clinical outcomes (Table 3).

There was no death during the operation and also no difference in the number of postoperative complications and the number of patients with residual intrahepatic duct stricture. However, Group A was charatered by a significantly shorter length of Hospital stay (13.5 ± 3.6 d vs 18.1 ± 5.6 d; p=0.032) and Postoperative hospital stay (9.5 ± 3.4 d vs 10.1 ± 5.4 d; p=0.026). Besides, Group A in the total bilirubin (24.7 ± 17.0 mmol/L vs 31.7 ± 22.2 mmol/L; p=0.027) and ALT (103.5 ± 61.0 U/L vs 120.2 ± 76.7 U/L; p=0.042) was obviously lower than Group B. Beyond that there were no significant difference in the other laboratory index (Table 4).

A typical case to illustrate the process of PTCSL based on PTOBF

A 66-year-old man was sent to hospital, before that he had already suffered from repeated abdominal pain for more than 30 years and caught a fever for more than 10 days. Preoperative CT: Diffuse dilatation was found in intrahepatic bile. High density shadow scattered around intrahepatic bile duct and common bile duct irregularly. In the end of the common bile duct, there was still a elliptic high density stone about 1.2 cm diameter (Figure 3A).

Preoperative MRCP: Intrahepatic bile duct had an obvious expansion, filling-defect of visible diffuse size like cast type scattered in the left and right intrahepatic bile duct and the common hepatic duct. Filling-defect was also found in the end of common bile duct. Preoperative diagnosis: 1, cholangitis, 2, hepatic chololithiasis.

With the consent of the patient and their families, the PTCSL based on PTOBF was applied.

First of all, a preoperative planning was designed based on the patients' preoperative data summary including the enhanced CT and MRCP. Preoperative data showed that there were diffuse stones in Ⅱ, Ⅲ, Ⅳ, Ⅴ, Ⅵ, Ⅶ, Ⅷ segment, and incarcerated stones in common bile duct calculus. Besides, the stones in Ⅲ, Ⅴ segment were very difficult to take out. For the purpose of removing the stones as completely as possible, two surgical pathways were applied as the principle of "cross" and it was necessary for two punturing point from both the left and right sides. With the guidence of intraoperative ultrasound the location and direction of puncture (Figure 3B) would be confirmed. Once the bile flow out, intraoperative biliary tract cholangiogram would show us detailed information of biliary tract.

TABLE 1

Preoperative clinical data in the two groups.

Variables	GroupA (n=103)	GroupB (n=86)	P value
Age, y, mean ± SD	52.6 ± 14.5	51.9 ± 13.6	0.927
Sex, male/female	57/46	42/44	0.373
Surgical history	81(78.6)	67(77.9)	0.903
HGB	120.7 ± 18.4	116.9 ± 18.8	0.820
TBIL, mmol/L, mean ± SD	19.1 ± 12.1	21.6 ± 14.9	0.312
ALT, U/L, mean ± SD	49.4 ± 40.2	52.5 ± 34.5	0.848
AST, U/L, mean ± SD	46.7 ± 29.8	43.2 ± 17.5	0.110
Plateles,10 × 9/L, mean ± SD	195.0 ± 73.2	180.4 ± 73.0	0.421
ALB, g/L, mean ± SD	38.0 ± 5.9	38.8 ± 6.5	0.676
Prothrombin time, s, mean ± SD	13.5 ± 1.1	13.5 ± 0.9	0.182
Biliary stricture			
S1	6(5.8)	3 (3.5)	0.514
S2	9(8.7)	3 (3.5)	0.141
S3	5(4.9)	6(7.0)	0.535
S4	9(8.7)	7(9.3)	0.924
S5	10(9.7)	8(66.1)	1.000
S6	14(13.6)	4(4.7)	0.037*
S7	12(11.7)	9(11.6)	0.796
S8	4(3.9)	3 (3.5)	1.000
Location of stone			
Left lobe	66(64.1)	57(66.3)	0.752
Right lobe	63(61.2)	44(51.2)	0.167
Bilateral	26(25.2)	15(17.4)	0.195
Common bile duct stones	44(42.7)	36(41.9)	0.905

TBIL: Total Bilirubin; ALT: Alanine Aminotransferase; AST: Aspartate Transaminase; ALB: Albumin; AFP: Alpha Fetoprotein; TACE: Transcatheter Arterial Chemoembolization

TABLE 2

Important index of the operation and the characteristics of the tumors found in the surgery

Variables	GroupA (n=103)	GroupB (n=86)	P value
Operative time, min, mean ± SD	81.5 ± 27.0	119.2 ± 42.2	0.000*
Intraoperative blood transfusion, ml, mean ± SD	0	0	0
Intraoperative blood loss, ml, mean ± SD	10.2 ± 19.9	10.8 ± 16.6	0.564
Percutaneous location			0.664
Left, n (%)	68(66.0)	63(73.3)	0.283
Right, n (%)	48(46.6)	34(39.5)	0.329
Bilateral, n (%)	13(12.6)	11(12.8)	0.972
Intermediate residual stone, n (%)	9(8.7)	16(18.6)	0.046*
Final residual stone, n (%)†	12(11.7)	22(25.6)	0.013*
Perioperative mortality, n (%)†	0	0	0

*† Based on intraoperative findings; * Significant difference*

TABLE 3

Postoperative clinical outcomes

Variables	GroupA (n=103)	GroupB (n=86)	P value
Postoperative complications, n (%)	9 (8.7)	10(11.6)	0.511
Recurrent cholangitis, n (%)	5(4.9)	7(8.1)	0.356
Bile leakage, n (%)	1 (1.0)	1 (1.2)	1.000
Intra-abdominal abscess, n (%)	0	1 (1.2)	0.455
Pleural effusion, n (%)	3 (2.9)	1 (1.2)	0.627
Pulmonary infection, n (%)	2 (1.9)	1 (1.2)	1.000
Haemorrhage, n (%)	2 (1.9)	2 (2.3)	1.000
Seroperitoneum, n (%)	1 (1.0)	0	1.000
Other, n (%)	1 (1.0)	1(1.2)	1.000
Hospital stay, d, mean ± SD	13.5 ± 3.6	18.1 ± 5.6	0.040*
Postoperative hospital stay, d, mean ± SD	9.5 ± 3.4	10.1 ± 5.4	0.026*
Residual intrahepatic duct stricture, n(%)	2 (1.9)	3 (3.5)	0.661
Perioperative mortality,n(%)	0	0	0

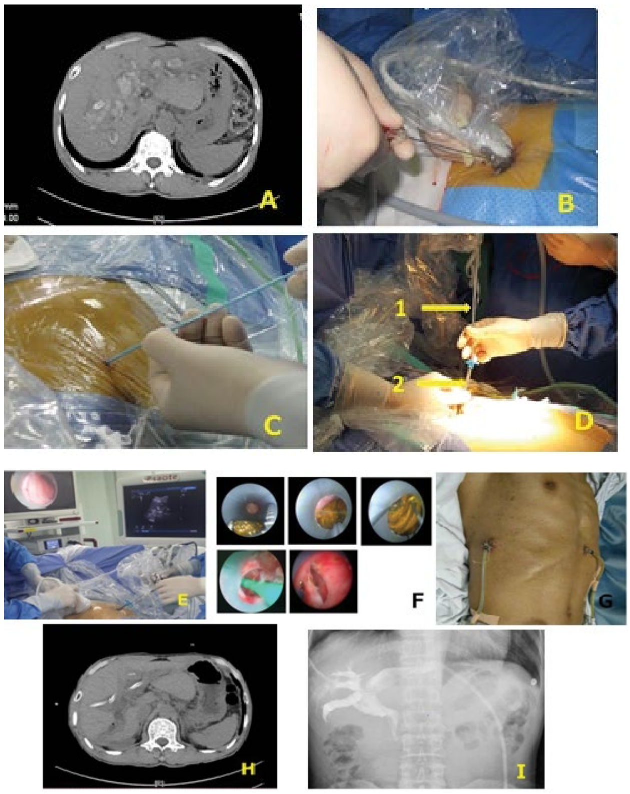
** Significant difference*

TABLE 4

Postoperative laboratory index in the two groups

Variables	GroupA (n=103)	GroupB (n=86)	P value
TBIL, mmol/L, mean ± SD	24.7 ± 17.0	31.7 ± 22.2	0.027*
ALB, g/L, mean ± SD	28.7 ± 6.8	28.1 ± 6.4	0.688
ALT, U/L, mean ± SD	103.5 ± 61.0	120.2 ± 76.7	0.042*
AST, U/L, mean ± SD	128.2 ± 56.5	127.5 ± 65.2	0.198
HGB, g/L, mean ± SD	112.2 ± 15.9	120.0 ± 20.6	0.070
Prothrombin time, s, mean ± SD	16.0 ± 3.2	16.4 ± 3.0	0.301

**Significant difference; TBIL: Total Bilirubin; ALB: Albumin; ALT: Alanine Aminotransferase; AST: Aspartate Transaminase; HGB: Hemoglobin*



A. Preoperative CT. B. Puncturing the biliary tract guided by intraoperative ultrasonography. C. Expanding the sinus directly by the dilator. D. Making a surgical entry by the protective sheath 1. rigid choledochoscope 2. the protective sheath. E. In the process of exploring the biliary tract, real - time detection and tracking can be made by intraoperative ultrasonography. F. The scene of lithotripsy and treating stenosis of the biliary duct;1-3. the scene of lithotripsy 4-5. treating stenosis of the biliary duct G. Placement of biliary drainage catheter H. Postoperative CT scan showing no residual stone in 7 days after PTCSL-based-on-PTOBF. I. Postoperative biliary tract cholangiogram showing no residual stone in 7 days after PTCSL-based-on-PTOBF.

Figure 3) *Operative procedure*

Secondly, a dilater was directly used to expand the sinus to 16 Fr which allowed us to place the 16 Fr protective sheath in Figures 3C-3D). In this way, a channel for rigid cholangioscope was established by the protective sheath. During the process of exploring the biliary tract, real-time detection and tracking can be made by intraoperative ultrasonography (Figure 3E).

During our operation, with the aid of pneumatic ballistic lithotrips, the large and hard calculus were first to be crushed. Hereafter, the shattered calculi could be flushed out by "wash and suction" function generated from the combined use of rigid cholangioscope and protective sheath. And the rest large stones could also be taken out with basket or clamp. Besides, there were two sections of stenosis found in bile duct Ⅷ segment. The columnar stenosis could be cut by an electric knife and expanded by biliary balloon dilator (Figure 3F).

Based on the preoperative planning, after puncturing from both right and left sides, all the calculis in the intrahepatic bile duct and common bile duct could be taken out as the principle of "cross" (Figure 3G). One week after operation, CT and postoperative biliary tract cholangiogram showed that the stones in intrahepatic bile duct and common bile duct had been cleared (Figures 3H-3I).

DISCUSSION

The difference between PTCSL based on PTOBF and traditional PTCSL

1. 3D-assisted operation planning and selection of surgical approach

Based on the experiences of PTCSL for almost 10 years, some theoretical foundation about selection of surgical approach was made a summary. Different surgical methods were chosen for removing the calculus in different positions.

For instance, there were 2 blind areas in the procedure of PTCSL, III and V segment where the calculus was difficult to remove. In that situation, the principle of "cross" would be our primary option.

a. To take out the stones in Ⅲ and left liver segment, puncturing point was chosen in the right hypochondriac region (between the ribs on the right side into the road, equivalent to Ⅵ, Ⅶ liver segment, but closed to Ⅶ liver segment) and the direction of puncturing towards the right intrahepatic bile duct with the guidance of intraoperative ultrasound.

b. To take out the stones in V and right hepatic segment, puncturing point was chosen in the abdominal region (anterolateral approach, under the xiphoid process and left and right sides of the rib soft build puncture "golden triangle", equivalent to Ⅱ, Ⅲ liver segment, but closed to Ⅱ liver segment) and the direction of puncturing towards the left intrahepatic bile duct with the guidance of intraoperative ultrasound.

In addition, with the aid of 3D reconstruction models, it was timely for us to obtain accurate information about the bile duct system, lesions, calculi distribution, and peripheral organs from many directions, different angles, and different strata, which made it more convenient for us to choose the optimization of surgical approach and operation planning.

2. Intraoperative real-time positioning by intraoperative ultrasound

Application of intraoperative ultrasound optimized the surgical approach and formed an intraoperative real-time positioning. At the same time, the combination of 3D imaging technique and preoperative imaging could provide operation planning with more information. What's more, the guidance of intraoperative ultrasound would also improve the success rate of percutaneous liver puncture and lower the trauma (16).

3. Percutaneous transhepatic one-step biliary fistulation and application of the protective sheath

In case of haemorrhage during operation, the sinus would not be expanded immediately after percutaneous biliary puncture was successfully accomplished in traditional PTCSL (17,18).

However, through our researches, we found that it would not cause haemorrhage during operation, as long as important vascular system structures were avoided. Then, expanding the sinus immediately would not cause massive haemorrhage during operation, either. In this study, it was proved that PTCSL based on PTOBF has not increased the risk of haemorrhage.

What's more, the protective sheath was substituted for the time-consuming natural sinus, which made it possible that the choledochoscope surgery could be performed immediately.

In general, PTCSL based on PTOBF was not just about this new technology (PTOBF, it was a standardized process of diagnosis and treatment based on PTOBF (Figure 1).

The advantages of PTCSL based on PTOBF

a. Reducing the times of hospitalization and the length of hopital stay: In the traditional PTCSL, it would take about 3 to 4 weeks to expand the sinus after PTC operation to establish a safe fistulous channel to the intrahepatic duct (19,20).

However, in the PTCSL based on PTOBF, the natural sinus was replaced by the protective sheath. As long as there was a successful PTC, the sinus would be directly expanded to 16 Fr to 18 Fr which could hold the protective sheath. Through the channel that was established by the protective sheath, rigid cholangioscopic lithotripsy could be performed immediately.

Therefore, the times of hospitalization and hospital stay would be both decreased.

b. More precise and efficient: 3D reconstruction models and other imaging data could display more accurate information about the bile duct system, lesions and calculi distribution (21). In addition, 3D reconstruction system could segment the liver individually (22,23). With the conclusion of the puncturing methods, the optimal surgical approach can be designed.

Application of intraoperative ultrasound optimized the surgical approach and formed an intraoperative real-time positioning, which could make the operation more precise, improve the success rate of percutaneous liver puncture and lower the trauma.

c. More flexible and effective: The using of protective sheath allowed PTCSL to be applied immediately after PTC. In some special cases, if some stones couldn't be driven out completely through the present puncture channel intraoperatively, another channel could be immediately established for a second puncture to take out the rest stones. According to actual needs multiple punctures can be applied in one operation, which is one of the main reasons why PTCSL based on PTOBF is more flexible and effective.

Meanwhile, more rational operation planning and more precise operation can contribute to lower residue stone rate, which made the treatment more effective.

ANALYSIS OF THE CLINICAL OUTCOMES

In this study, the 2 groups shared similarities in demographics and clinical characteristics, while there were some significant differences in the number of patients with biliary strictures of S6 (14 in group A and 4 in group B; p=0.037), which was owing to lack of more samples or to some selective bias.

The Operative time in Group A was significantly less than that in Group B (81.5+27 VS 119.2+42.2; p=0.000) which was caused by "wash and suction" function generated fir the combined using of rigid cholangioscope and protective sheath that made calculus remove more convenient (shattered stones can be directly flushed out through the sheath, which would speed up the efficiency of PTCSL. In addition, if the multiple puncture point was necessary during the traditional PTCSL, it would be difficult to adjust the puntrure points timely during the operation.

The lower Intermediate residual stone and final residual stone in group A was attributed in part to the use of the combination of 3D reconstruction and intraoperative ultrasound, which made it more accurate in detecting and locating deep stones in the liver parenchyma. Furthermore, with the aid of the new technique (PTOBF), multiple punctures can be applied in one operation as necessary, which make the treatment more efficient and effective.

Group A presented us with a significantly shorter length of Hospital stay (13.5 ± 3.6 d vs 18.1 ± 5.6 d; p=0.032) and Postoperative hospital stay (9.5 ± 3.4 d vs 10.1 ± 5.4 d; p=0.026). Compared with traditional PTCSL, it needn't waste time on sinus expanding by PTCSL based on PTOBF, which mainly resulted in reducing hospitalizations and the times of operation.

By and large, Group A charactered itself with less operative time and less surgery times, so that the patients of Group A have a faster postoperative recovery and need less postoperative hospital stay, which may be the direct reason why the total bilirubin and ALT in Group A were lower than that in Group B23.

The two groups shared the similar index in terms of Intraoperative blood transfusion, Intraoperative blood loss, Percutaneous location and Perioperative mortality and there was also no significant difference in the number of postoperative complications.

This study stimulated us to come a conclusion that compared with traditional PTCSL, The PTCSL based on PTOBF could achieved more effective treatment without increasing the perioperative and surgical risk.

LIMITATIONS AND PROSPECTS

This study was limited by its retrospective nature and selective bias in general. Besides the data from the patients were short-term, which was believed to impair the study to some degree. Therefore, additional long-term research would be worthwhile in order to achieve a more assertive conclusion about the effects.

CONCLUSION

Compared with traditional PTCSL, The PTCSL based on PTOBF could not only obtain the same treatment effect without increasing the risk of perioperative and surgical but also reduce the operation times and hospital stay. In a word, the PTCSL based on PTOBF was more efficient and effective for the treatment of patients with complicated hepatic chololithiasis.

FUNDING

Funding sources: Medical Scientific Research Foundation of Guangdong Province, China (grant no. A2013254).

Disclosure: All authors have no conflicts of interest or financial ties to disclose.

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