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Risk Factors Associated With Residual Stones in Common Bile Duct Via T Tube Cholangiography After Common Bile Duct Exploration

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Abstract: Open surgery with common bile duct (CBD) exploration and T tube drainage are still traditionally performed in a large amount of selected patients with cholelithiasis and choledocholithiasis. Confirmation of CBD clearance via T tube cholangiography after surgery is a routine procedure before T tube removal. The present study aims at investigating potential risk factors associated with residual stones in CBD via T tube cholangiography.

Patients undergoing open CBD exploration and T tube drainage for choledocholithiasis in the hospital were enrolled retrospectively from January 2011 to December 2013. The clinical data were reviewed and analyzed based on computer database. Patients undergoing laparoscopic CBD exploration were excluded. Patients with CBD exploration and primary choledochotomy or choledochojejunostomy were also excluded from the study. T tube cholangiography was regularly performed 4 to 8 weeks postoperatively.

Two hundred seventy-five patients undergoing open CBD exploration and T tube drainage were enrolled in the study. Thirty-five patients (12.7%) were found to have gallbladder stones but without bile duct stones intraoperatively (Group A). One hundred sixty-five (Group B) and 77 patients (Group C) were diagnosed with choledocholithiasis and hepato-choledocholithiasis in operation, respectively. Disease of hepato-choledocholithiasis, size of the previous stones, and CBD exploration without intraoperative choledochoscopy were identified as risk factors associated with residue stones via T tube cholangiography ($P < 0.001$, $P = 0.034$, and $P = 0.047$, respectively). Patients with residual stones had a higher incidence of cholangitis during cholangiography than those without residual stones (8.9% vs 7.8%, $P = 0.05$). A scoring system based on the 3 risk factors has been set up. The incidence of residual stones were 5.6% in patients with score 0 to 1, 27.4% in patients with score 2 to 3 and 80.0% in patients with score 4 ($P < 0.001$). Abdominal distension after T tube clamp might be a strong predictor of cholangiography-associated choloangitis ($P < 0.001$).

Intraopearative choledochoscopy should be strongly recommended as a routine procedure during CBD exploration to confirm the clearance of CBD, which could significantly lower the risk of residual stones postoperatively.

(*Medicine* 94(26):e1043)

Abbreviations: CAC = cholangiography-associated cholangitis, CBD = common bile duct, ERCP = endoscopic retrograde cholangiopancreatography, EUS = endoscopic ultrasound, MRCP = magnetic resonance cholangiopancreatography.

INTRODUCTION

Biliary lithiasis is an endemic condition in both Eastern and Western countries, affecting 20% of the general population.[1,2] It is reported that 10% to 20% of patients with cholelithiasis also have concomitant common bile duct (CBD) stones at the time of surgery.[3–5] Although half of patients with cholelithiasis remain asymptomatic, those with choledocholithiasis may present with colicky pain to potentially life-threatening complications, such as ascending cholangitis or acute pancreatitis, due to obstruction of the bile/pancreatic juice flow.[1,6]

Diagnosis and management of choledocholithiasis have evolved over 30 years. However, despite the wide variety of examinations and techniques available nowadays in different centers, 2 main open issues remain and might be solved differently by physicians in different centers: how to cost-effectively diagnose choledocholithiasis; (2) when it is diagnosed, how to deal with the condition with minimal morbidities.[1] With wide application of endoscopic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiopancreatography (MRCP), and endoscopic ultrasound (EUS), diagnosis of choledocholithiasis is not difficult. In most cases, CBD stones are due to migration of gallstones, which is still in situ; therefore, cholecystectomy is also indicated. There are 3 mostly accepted methods in management of choledocholithiasis: open surgery, laparoscopy (one-step method), and various endoscopic–laparoscopic protocols (2-step method). Nevertheless, open surgery is invasive, whereas the laparoscopic CBD exploration is time-consuming, technically demanding, and involves dedicated instruments, and endoscopic methods cause impairment of duodenal papilla. Thus, although no consensus has been achieved, it is advocated that CBD exploration is more conditioned by the availability of instrumentation, personnel, and skills of the physician.

Open surgery is preferred in some hospitals for concomitant cholelithiasis and choledocholithiasis as CBD exploration and T tube drainage. T tube is regularly maintained for 4 to 8 weeks after surgery, and withdrew after confirmation of CBD clearance by cholangiography. However, during cholangiography, residue stones are occasionally found. This would spur the surgeons to

Editor: Muhammed Mubarak.
Received: April 22, 2015; revised: May 27, 2015; accepted: May 28, 2015.
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Grant support: This work was supported in part by National Natural Science Foundation (NO. 81372582, 81101873).
The authors declare no conflict of interest.

ISSN: 0025-7974
DOI: 10.1097/MD.0000000000001043

learn from the previous surgeries, and then to investigate improvement of surgical techniques and skills. The present study aims at analyzing the clinical data of the patients undergoing CBD exploration and T tube drainage by open surgery, and investigating proper risk factors associated with residue stones via T tube cholangiography after surgery.

PATIENTS AND METHODS

Patients

A total of 275 patients undergoing open CBD exploration and T tube drainage for choledocholithiasis were enrolled retrospectively from January 2011 to December 2013 in the First Affiliated Hospital of Medical College, Xi'an Jiaotong University, China. The patients were diagnosed with suspicious choledocholithiasis by history, physical examination, biochemical data, preoperative abdominal ultrasonography, MRCP, or ERCP. The clinical data were reviewed and analyzed based on computer database. Patients undergoing laparoscopic CBD exploration were excluded, as it was not mainly performed in the hospital during the study period. Patients with CBD exploration and primary choledochotomy or choledochojejunostomy were also excluded from the study. This protocol was approved by the ethics committee of the First Affiliated Hospital, Xi'an Jiaotong University on the premise of obtaining the voluntary informed consent of enrolled patients. Informed oral or written consent for the use of the patient's clinical data was requested from the patients or their relatives during the follow-up.

Surgical Procedure

The operation was started with cholecystectomy in 189 patients, since cholelithiasis was diagnosed definitely pre- and intraoperatively. The rest 86 patients had a history of previous cholecystectomy, but were diagnosed with choledocholithiasis at this time. The anterior aspect wall of CBD was cleared for approximately 1 to 2 cm. Choledochotomy was performed longitudinally on the anterior wall of the supraduodenal part of CBD. A lithotomy forceps or stone spatulas were routinely used to withdraw the stones. A 5-mm flexible choledochoscope was used in some patients (Olympus, Tokyo, Japan) to confirm the residue stones in CBD. If necessary, a Dormia basket (Cook, Bloomington, IN) was used to retrieve the stones. Once some impacted stones were difficult to manage by the basket, electrohydraulic lithotripsy was used. Finally, clearance of the stones was confirmed by choledochoscopy. However, this was not the routine procedure in all cases. If choledochoscopy was unavailable, a plastic catheter would be introduced to CBD to explore whether any obstruction exists in the end and duodenal papilla.

After clearance of stones, a latex rubber T-tube of appropriate size (14–20 Fr) was inserted into the CBD incision, and the CBD was then closed interruptedly. Saline was flushed through the T-tube to detect possible leakage. A single drainage tube was placed in Winslow's hole near the CBD incision in all patients, which was removed 2 to 3 days after surgery if there was no bile leak. Antibiotic prophylaxis was routinely used for 24 to 48 hours. After surgery, the drainage volume of T tube was checked daily. The patients were discharged with T tube in situ. They were asked to interruptedly clamp the T tube 2 to 3 weeks after surgery. T tube must be reopened, if the patient developed fever, jaundice, or any abdominal distension. Interrupted attempt of T tube clamp could be performed by the patient after consulting with their doctors during the follow-up. One to 2 months later, the patient should come to the hospital for cholangiography via T tube. However, before cholangiography, opening of T tube drainage for at least 24 hours was routinely recommended to all the patients.

After disinfection of the T tube joints, a 20-ml syringe with 1:1 Ominipaque and saline was connected with T tube, and the dye was injected slowly under X-ray. After cholangiography, T tube was opened for at least 24 hours. If the patient developed chills and fever within 24 hours after cholangiography (cholangiography-associated cholangitis, CAC), 5-mg dexamethasone and broad-spectrum antibiotics would be prescribed till the symptoms were under control. If no residue stone was examined, T tube would be removed the next day. If residue stones were suspected, choledochoscopy would be used through the sinus of the T tube to retrieve the residue stones.

Follow-Up

The patients were routinely followed up at least 1 year after the surgery. Follow-up assessment using ultrasound and liver function tests was undertaken in outpatient department, and with MRCP if necessary, for possible recurred bile duct stones.

Statistical Analysis

The variables were expressed as mean ± standard error (SE) or median value for quantitative variables, and percentages for qualitative variables. For comparison of the variables between different groups, Mann–Whitney U test or Student t tests was used for quantitative variables, and the χ^2 test or Fisher exact test was applied to qualitative variables. A level of $P < 0.05$ was considered statistically significant. Data were analyzed using software package IBM® SPSS® Statistics® version 21 for Windows (SPSS Inc, Chicago, IL).

RESULTS

A total of 275 patients undergoing open CBD exploration and T tube drainage were enrolled in the study. Thirty-five patients (12.7%) were found to have gallbladder stones but without bile duct stones intraoperatively (Group A). One hundred sixty-three (Group B) and 77 patients (Group C) were diagnosed as having choledocholithiasis and hepatocholedocholithiasis in operation, respectively. The average size of the stones was 1.1 cm. As shown in Table 1, the patients in the 3 groups were not different in age, sex, stone size, complications after T tube clamp, time of T tube cholangiography, or T tube opening prior to chaolangiography. Postoperative complications were presented totally in 19 patients (6.9%), which were not differently distributed between the 3 groups ($P = 0.876$). The 2 patients in group A, 1 patient in group B, and 1 patient in group C experienced premature dislodgement. Replacement of the T tube by a plastic nasogastric tube through the sinus was successful in all these 4 patients, and no reoperation was needed. Five patients in group B and 3 patients in group C developed bile leak, but after 3 to 7 days of drainage via abdominal tube, they were all recovered without bile peritonitis. Moreover, 1 patient in group A, 6 patients in group B, and 5 patients in group C had wound infection after surgery, but recovered after daily wound dressing, and no surgery was needed. However, the proportion of choledochoscopic exploration of the bile duct was higher in group B and C than group A ($P = 0.001$ and $P = 0.010$, respectively). After cholangiography via T tube, residue stones were much more frequently observed in group C than group B and A (31.2% vs. 10.4% and 11.4%, $P < 0.001$). It is noticeable that 4 patients in group A were found

TABLE 1. Clinical Characteristics and T Tube Drainage of the Patients According to Different Primary Disease

Variables	Group A: Cholecystolithiasis (n = 35)	Group B: Choledocholithiasis (n = 163)	Group C: Hepato-choledocholithiasis (n = 77)	*P*
Age, years	60 ± 2	60 ± 1	55 ± 1	0.053
Female sex	20 (57.1%)	78 (47.9%)	48 (62.3%)	0.123
Size of stones in CBD, cm	–	1.0 ± 0.1	1.2 ± 0.1	0.060*
Use of intraoperative choledochoscopy	24 (68.6%)	148 (90.8%)	67 (87%)	0.002
Average drainage volume via T tube, mL	262 ± 17	323 ± 10	316 ± 18	0.050
Abdominal distention after T tube clamp	2 (5.7%)	18 (11.0%)	9 (11.7%)	0.602
Postoperative complications	2 (5.7%)	11 (6.7%)	6 (7.8%)	0.876
Time interval from surgery to T tube cholangiography, weeks	5 ± 1	5 ± 0.2	5 ± 0.4	0.541
Opening of T tube 24 hours before cholangiography	30 (85.7%)	142 (87.1%)	68 (88.3%)	0.925
Residual stones found by cholangiography	4 (11.4%)	17 (10.4%)	24 (31.2%)	<0.001
Cholangitis after cholangiography	3/25 (12%)	8/117 (6.7%)	11 /46 (23.9%)	0.009
Recurred CBD stones within 1 year after surgery	1/25 (4%)	8/117 (6.7%)	7/46 (15.2%)	0.155

CBD = common bile duct.
* Compared only between the last 2 groups.

to have residual stones in CBD by T tube cholangiography, but had been diagnosed as having no stones in CBD during exploration. When we checked the operation records, 3 of the 4 had not been explored by choledochoscopy, and the rest one had been explored but found no stones in CBD as recorded. Moreover, the complication of cholangitis after cholangiography was higher in group C, compared with group A and group B ($P = 0.009$), which was, however, not different between group A and B ($P = 0.381$). All the patients with residue stones received treatment by choledochoscopy via T tube sinus. During the first 1 year, the incidence of recurred stones in CBD seemed higher in group C than group A and B (15.2% vs. 4% and 6.7%), which, however, was not statistically different ($P = 0.155$).

Next, we asked what factors might probably contribute to cholangitis after T tube cholangiography. The data were available in 188 patients and some proper risk factors were analyzed as shown in Table 2. A total of 22 patients (11.7%) developed CAC. It seems to be true that patients with previously diagnosed hepatocholedocholithiasis had higher incidence of CAC ($P = 0.009$). Whether or not to use intraoperative choledochoscopy is also correlated with CAC ($P = 0.027$). Moreover, abdominal distension after T tube clamp might be a strong

TABLE 2. Risk Factors and Outcome Contributing to Cholangitis After T Tube Cholangiography in 188 Patients

Variables	Cholangitis		*P*
	Present (n = 22)	Absent (n = 166)	
Age, years	55 ± 2.1	60 ± 1.2	0.107
Female sex	11 (50.0%)	84 (50.6%)	1.000
Primary disease			0.009
Cholecystolithiasis	3 (13.6%)	22 (13.3%)	
Choledocholithiasis	8 (36.4%)	109 (65.7%)	
Hepato-choledocholithiasis	11 (50.0%)	35 (21.1%)	
Number of stones in CBD			0.323
None	3 (13.6%)	23 (13.9%)	
Single	3 (13.6%)	49 (29.5%)	
Multiple	16 (72.8%)	94 (56.6%)	
Size of stones in CBD, cm	0.9 ± 0.2	0.9 ± 0.1	0.952
Use of intraoperative choledochoscopy	16 (72.8%)	150 (90.4%)	0.027
Average drainage volume via T tube, mL	295 ± 28	317 ± 10.3	0.463
Abdominal distention after clamp of T tube	11 (50.0%)	14 (8.4%)	<0.001
Time interval from surgery to T tube cholangiography, weeks	5.8 ± 0.7	5.2 ± 0.2	0.356
Opening of T tube 24 hours before cholangiography	15 (68.2%)	140 (84.3%)	0.075
Residual stones during T tube cholangiography	4 (18.2%)	41 (24.7%)	0.050
Recurred CBD stones within 1 year after surgery	6 (27.3%)	10 (6.0%)	0.005

CBD = common bile duct.

TABLE 3. Risk Factors and Outcome Associated With Residual Stones in Common Bile Duct Via T Tube Cholangiography in 275 Patients

Variables	Residual Stones in CBD		P
	Positive (n = 45)	Negative (n = 230)	
Age, years	58 ± 2	59 ± 1	0.812
Female sex	27 (60.0%)	119 (51.7%)	0.331
Primary disease			<0.001
Cholecystolithiasis	4 (8.9%)	31 (13.5%)	
Choledocholithiasis	17 (37.8%)	146 (63.5%)	
Hepato-choledocholithiasis	24 (53.3%)	53 (23%)	
Stones numbers in bile ducts in first surgery			0.191
None	4 (8.9%)	31 (13.5%)	
Single	9 (20.0%)	69 (30.0%)	
Multiple	32 (71.1%)	130 (56.5%)	
Previous size of stones in CBD, cm	1.2 ± 0.1	0.9 ± 0	0.034
Use of intraoperative choledochoscopy	35 (77.8%)	204 (88.7%)	0.047
Average drainage volume via T tube, mL	325 ± 24	311 ± 8	0.509
Abdominal distention after clamp of T tube	5 (11.1%)	24 (10.4%)	0.797
Time interval from surgery to T tube cholangiography, weeks	5 ± 0.7	5 ± 0.2	0.480
Opening of T tube 24 hours before cholangiography	42 (93.3%)	198 (86.1%)	0.227
Cholangitis during T tube cholangiography	4 (8.9%)	18 (7.8%)	0.050
Recurred CBD stones within 1 year after surgery	4/13 (30.8%)	12/175 (16.0%)	0.016

CBD = common bile duct.

predictor of CAC risk ($P < 0.001$). It was interesting that patients who had developed CAC had higher incidence of recurred CBD stones within 1 year after surgery ($P = 0.005$).

Findings of stones in bile duct via T tube cholangiography within 1 to 2 months after surgery might signify that the bile duct stones had been not cleared during the previous surgery. Therefore, it was important to find out risk factors associated with residue stones in bile ducts. In Table 3, 11 potential risk factors were included. It was obvious that most patients (53.3%) with residue stones via T tube cholangiography had a history of hepatocholedocholithiasis ($P < 0.001$). Size of the previous stones in bile ducts seemed to be correlated with the incidence of residual stones as well ($P = 0.034$). A total of 77.8% of the patients with residual stones have experienced bile duct exploration by choledochoscopy, whereas 88.7% of the patients without residual stones have experienced this procedure ($P = 0.047$). This means that use of intraoperative choledochoscopy could help lowering the risk of residual stones after surgery. It seemed that patients with residual stones had a higher incidence of cholangitis during cholangiography than those without residual stones (8.9% vs. 7.8%, $P = 0.05$). Interestingly, even after clearance of residual stones by choledochoscopy, some patients developed recurred CBD stones within 1 year after surgery (30.8% with residue stones, vs. 16% without residual stones, $P = 0.016$).

Three strong risk factors associated with residual stones after CBD exploration were then enrolled including primary disease, stone size during the first operation, and use of intraoperative choledochoscopy. And based on the 3 risk factors, a scoring system has been built in Table 4. The score of patient varies from 0 to 4 with sum of each variable before T tube cholangiography. We further categorized all the patients as stage I (score 0–1), stage II (score 2–3), and stage III (score 4) (Table 5). The incidence of residual stones were 5.6% in stage I, 27.4% in stage II, and 80.0% in stage III ($P < 0.001$, Table 5).

DISCUSSION

Although open surgery for cholelithiasis and choledocholithiasis is increasingly less performed due to the rapid progress of laparoscopic and endoscopic techniques since the 1990s, recent studies seem to show the superiority of open surgery to ERCP in achieving CBD stones clearance.[6,7] A recent extensive literature review of 16 published randomized trials comparing the results of cholecystocholedocholithiasis management by open surgery, laparoscopy, and endoscopic-laparoscopic protocols, did not show any significant difference concerning

TABLE 4. Scoring System Predicting Residual Stones via T Tube Cholangiography After Common Bile Duct Exploration Based on the Risk Factors

Risk Factors	Scores
Primary disease	0, Cholecystolithiasis
	1, choledocholithiasis with/without cholecystolithiasis
	2, Hepato-choledocholithiasis
Stone size during the first operation	0, The maximal diameter <1 cm
	1, The maximal diameter ≥1cm
Use of intraoperative choledochoscopy	0, Yes
	1, No

TABLE 5. Number of patients in different scoring stages

Stage	Scores	With Residual Stones	With No Residual Stones	In Total
Stage I	0–1	7 (5.6%)	119 (94.4%)	126
Stage II	2–3	34 (27.4%)	110 (72.6%)	144
Stage III	4	4 (80.0%)	1 (20.0%)	5
In total		230 (83.6%)	45 (16.4%)	275

overall mortality and morbidity, ranging from 0% to 3% and 13% to 20%.[6] However, the cumulative rate of residual stones was significantly lower in group with open surgery than groups with 2-step protocols (laparoscopic cholecystectomy and endoscopic sphincterotomy) (6% vs 16%). Therefore, they concluded that open bile duct surgery seemed to be superior to ERCP in achieving CBD stone clearance without increasing morbidity and mortality, although it was associated with longer hospital stay.[6] Moreover, laparoscopic CBD exploration and ERCP are limitedly diffused in most rural hospitals due to the necessary learning curve, longer operative times, and lack of equipment.[8,9] Therefore, open surgery must be never obsolete and negligible, as it is applicable to complex cases or those needing conversion/revision during mini-invasive methods.

After the removal of the stones in CBD, the cut in CBD has to be stitched. Many surgeons use a T tube through the cut in the CBD. One of the reasons for use of T tube drainage is to decompress CBD in the presence of pressure of duodenal papilla sphincter. Insertion of T tube could support the cut portion in CBD, preventing the build-up of bile due to temporary swelling and leakage of bile in the cut.[10,11] Another reason is to allow the possibility of extracting residual stones through the T tube tract.[10,11] This is frequently used if the choledochoscope is unavailable and clearance of CBD cannot be confirmed. T tube retain would make an opportunity for re-extracting stones thorough the sinus, avoiding ERCP and endoscopic sphincterotomy or even reoperation. However, due to the potential complications and possible prolonged hospital stay and increased costs related to T tube drainage, primary closure of the CBD cut is nowadays advocated increasingly. A recent comprehensive review enrolled 6 trials evaluating primary closure and T tube drainage after open CBD exploration. No difference of mortality and complication rates was found between the 2 groups, although T tube drainage was correlated with longer hospital stay and higher costs.[11] However, this might not to be true in all cases, as introducing a T tube is easy and not that costly. None of the trials reported quality of life or the time taken for patients to return to work. According to recent guidelines, the choice of the best management will be increasingly tailored not only to a specific patient but also to the local presence of professional expertise and available resources, rather than to a real superiority of one strategy over another.[11,12] In the present study, the postoperative complication rates were 6.9%, which was lower than previous reports with T tube drainage, varying from 10.5% to 20%.[11,13–15] None of the patients died within hospital. It might indicate open surgery with T tube drainage has minimal postoperative morbidity rates in our center now, which is the indication to many patients.

Before retrieval of the T tube, dye can be injected into the T-tube and an X-ray used to demonstrate any residual stones. Once the absence of residual stones is confirmed, the T-tube would be removed.[11,16] T tube sinus tract formation is the precondition of T tube extubation. The formation of T tube sinus needs at least 3 weeks. Therefore, we maintained the T tube for 4 to 8 weeks depending on the symptoms of the patients after T tube clamping. Once the patient complained abdominal distension or pain after T tube clamping, the tube would be reopened for 1 to 2 days before the next clamping. If the symptoms lasted for 8 weeks postoperatively, a T tube cholangiography would be performed without further clamping. However, once any obstruction of CBD is observed, a choledochoscopy must be performed for diagnosis and stone extraction. It is believed that the residual stones in CBD by T tube cholangiography must be attributed to the previous surgery. Therefore, it is important to re-evaluate the surgical procedure and patient's relevant conditions during the previous surgery in the patients with residual stones. In the present study, we enrolled 11 potential risk factors, which might signify the residual stones by T tube cholangiography. We found hepatocholedocholithiasis, size of the stones, and CBD exploration without choledochoscopy in the previous surgery might be strongly correlated to the postoperative residual stones. Hepatocholedocholithiasis is complex and always needs a long time of surgery for stone extraction, and some stones in peripheral intrahepatic bile ducts are difficult to reach. Mobilization and movement of the residual stones from the intrahepatic bile ducts to extrahepatic bile ducts frequently occurred after the first surgery. Therefore, these kinds of patients might need further bilioenteric anastomosis several years later. Size might have some impacts in clearance of the stones, especially when the stones are loose. Intraoperative choledochoscopy should be routinely used in CBD exploration, which allows viewing the CBD and even intrahepatic bile ducts under direct vision.[17–19] Cholangitis during T tube cholangiography might also be a marker of residual stones, although it is highly as a result of stone obstruction of CBD. Even after choledochoscopic exploration through T tube sinus, the patients with residual stones had higher incidence of recurred CBD stones within 1 year after surgery. Based on the 3 potential risk factors, we tried to build up a scoring system for predicting residual stones in CBD (Table 4). Patients with score 4 had highest risk of residual stones than those with score 2 to 3 and score 0 to 1 (80% vs 27.4% vs 5.6%, $P < 0.001$, respectively, Table 5). Therefore, patients with hepatocholedocholithiasis and large stones previously should be carefully checked by T tube cholangiography, especially when intraoperative choledochoscopy has not been performed. However, operation skills for a personal surgeon must be also important for the CBD clearance, which, however, could not be objectively documented in the study.

Cholangitis is a severe complication during cholangiography via T tube. As documented in the present study, 22 patients of the 188 patients (11.7%) developed cholangitis shortly after T tube cholangiography. We analyzed the potential risk factors correlated with cholangitis. It seemed that previous hepatocholedocholithiasis, CBD exploration without intraoperative choledochoscopy, and residual stones might be strongly predictive

for higher risk of cholangitis after T tube cholangiography. However, it might be true that previous hepatocholedocholithiasis and CBD exploration without intraoperative choledochoscopy would lead to higher risk of residual stones, which caused CBD obstruction and bile reflux into the liver, thus higher risk of cholangitis. Noticeably, 50% of the patients with abdominal distension after clamp of the T tube developed cholangitis, whereas the ratio was only 8.4% without abdominal distension after clamp of the T tube ($P < 0.001$). Abdominal distension after clamp of the T tube might indicate obstruction of the CBD by stones. Therefore, for the patients having the above-mentioned symptom, dye injection via T tube should be slower and disinfection should be more strictly obeyed during cholangiography. Similarly, operation skills must be also important for the occurrence of cholangitis during cholangiography, which, however, could not be obtained in such a retrospective study.

CONCLUSION

Confirmation of CBD clearance via T tube cholangiography is important for the evaluation of the previous surgery and recovery of the patients. Patients with previous diagnosis of hepatocholedocholithiasis, large stone size, and CBD exploration without choledochoscopy during the previous surgery may have high risk of residual stones in CBD. Therefore, intraopearative choledochoscopy should be strongly recommended as a routine procedure during CBD exploration.

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