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ORIGINAL ARTICLE

Case Control Study

Hepatectomy with primary closure of common bile duct for hepatolithiasis combined with choledocholithiasis

Chang-Ku Jia, Jie Weng, You-Ke Chen, Qing-Zhuang Yang, Yu Fu, Qi-Fan Qin, Wei-Ming Yu

Chang-Ku Jia, Jie Weng, You-Ke Chen, Qing-Zhuang Yang, Yu Fu, Department of Hepatobiliary Pancreatic Surgery, The Affiliated Hospital of Hainan Medical College, Haikou 570102, Hainan Province, China
Qi-Fan Qin, Department of General Surgery, Lin'gao County Hospital, Lin'gao 571800, Hainan Province, China
Wei-Ming Yu, Department of General Surgery, Lin'an Municipal Hospital, Lin'an 311300, Zhejiang Province, China
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Correspondence to: Wei-Ming Yu, MD, Department of General Surgery, Lin'an Municipal Hospital, No. 548 Yijin Street, Lin'an 311300, Zhejiang Province, China. 18976452639@126.com
Telephone: +86-898-66789287
Fax: +86-898-66528336
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Abstract

AIM: To evaluate the feasibility of hepatectomy and primary closure of common bile duct for intrahepatic and extrahepatic calculi.

METHODS: From January 2008 to May 2013, anatomic hepatectomy followed by biliary tract exploration without biliary drainage (non-drainage group) was performed in 43 patients with intrahepatic and extrahepatic calculi. After hepatectomy, flexible choledochoscopy was used to extract residual stones and observe the intrahepatic bile duct and common bile duct (CBD) for determination of biliary stricture and dilatation. Function of the sphincter of Oddi was determined by manometry of the CBD. Primary closure of the CBD without T-tube drainage or bilioenteric anastomosis was performed when there was no biliary stricture or sphincter of Oddi dysfunction. Dexamethasone and anisodamine were intravenously injected 2-3 d after surgery to prevent postoperative retrograde infection due to intraoperative bile duct irrigation, and to maintain relaxation of the sphincter of Oddi, respectively. During the same period, anatomic hepatectomy followed by biliary tract exploration with biliary drainage (drainage group) was performed in 48 patients as the control group. Postoperative complications and hospital stay were compared between the two groups.

RESULTS: There was no operative mortality in either group of patients. Compared to intrahepatic and extrabiliary drainage, hepatectomy with primary closure of the CBD (non-drainage) did not increase the incidence

of complications, including residual stones, bile leakage, pancreatitis and cholangitis ($P > 0.05$). Postoperative hospital stay and costs were nevertheless significantly less in the non-drainage group than in the drainage group. The median postoperative hospital stay was shorter in the non-drainage group than in the drainage group (11.2 ± 2.8 d *vs* 15.4 ± 2.1 d, $P = 0.000$). The average postoperative cost of treatment was lower in the non-drainage group than in the drainage group (29325.6 ± 5668.2 yuan *vs* 32933.3 ± 6235.1 yuan, $P = 0.005$).

CONCLUSION: Hepatectomy followed by choledocho-endoscopic stone extraction without biliary drainage is a safe and effective treatment of hepatolithiasis combined with choledocholithiasis.

Key words: Hepatolithiasis; Choledocholithiasis; Primary closure; Hepatectomy; Biliary drainage

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Core tip: We performed hepatectomy with primary closure of the common bile duct for hepatolithiasis combined with choledocholithiasis. Postoperative complications including residual stones, bile leakage, pancreatitis and cholangitis were equivalent in the drainage and non-drainage groups. Postoperative hospital stay and costs were nevertheless significantly less in the non-drainage than in the drainage group. Additional biliary drainage is not necessary for all patients with intrahepatic and extrahepatic calculi, thus avoiding unnecessary discomfort and extra costs. Anatomic hepatectomy followed by intraoperative choledochoendoscopic stone extraction without biliary drainage in selected patients is a safe and effective treatment.

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INTRODUCTION

Intrahepatic and extrahepatic lithiasis is a common disease in Asia, especially in East and Southeast Asia. Calculi, biliary infection, biliary stricture and hepatic parenchymal fibrosis make it a complicated and intractable clinical problem. Various treatments have been proposed for intrahepatic and extrahepatic lithiasis; however, no consensus has been reached on the ideal treatment. Surgery achieves good results with low morbidity and mortality[1,2]. Potential operations for intrahepatic and extrahepatic lithiasis include: (1) hepatectomy; (2) extraction of calculi *via* choledochotomy; and (3) placement of a T-tube or creation of a bilioenteric anastomosis[1]. Hepatectomy of the affected segment, including intrahepatic calculi and potential biliary stenoses, is probably the best therapeutic option, because it achieves the best long-term results[3-5].

Traditionally, after resection of hepatic lesions and choledochotomy, the common bile duct (CBD) is drained with a T-tube for choledocholithiasis combined with hepatolithiasis. However, insertion of a T-tube is related to some potential postoperative complications. Some of these complications are serious, such as bile leak, biliary tract infection, or acute renal failure from dehydration due to inadequate water ingestion or a high outflow. In addition, patients must carry the T-tube for several weeks before its removal, causing significant discomfort[6-8]. Choledochoduodenostomy has been performed at many hospitals for many years worldwide, and is considered a safe and effective method for treatment of choledocholithiasis[9-15]. However, the use of choledochoduodenostomy for treatment of hepatolithiasis has been controversial for a long time[16,17]. Choledochoduodenostomy does not entirely achieve the goal of stone clearance, correction of strictures, and removal of hepatobiliary lesions by itself, thus, there is no definitive evidence to show the long-term outcomes of choledochoduodenostomy for hepatolithiasis. Moreover, choledochoduodenostomy without cholangioplasty results in an increase of severe reflux cholangitis due to the loss of the anti-reflux function of the sphincter of Oddi. Therefore, choledochoduodenostomy is not an ideal approach to reduce cholangitis in hepatolithiasis and is not the best choice in the management of hepatolithiasis[18,19]. Hepaticojejunostomy, another drainage modality, is also an imperfect solution due to recurrence of symptoms. Herman *et al*[20] found that 41.2% of patients who underwent liver resection associated with hepaticojejunostomy had late postoperative complications such as cholangitis or liver abscess during follow-up. Similar to choledochoduodenostomy and hepaticojejunostomy, choledochojejunostomy is used to drain fluid in patients with hepatolithiasis complicated with intrahepatic biliary stricture after partial hepatectomy and hilar cholangioplasty. However, loss of the sphincter of Oddi, biliary reflux, and gastrointestinal dysfunction often occur after traditional choledochojejunostomy[16,21,22]. Finally, the rate of cholangiocarcinoma is related to that of cholangitis, which occurs in choledochoduodenostomy and hepaticojejunostomy[23], making bilioenteric anastomosis a controversial procedure.

We have performed a retrospective study of hepatectomy with primary closure of the CBD or biliary drainage for treatment of hepatolithiasis combined with choledocholithiasis. The purpose of the present study was to evaluate the feasibility and efficacy of hepatectomy and primary closure of the CBD for intrahepatic and extrahepatic lithiasis.

Table 1 Calculus distribution, liver lesions and operations

Calculus distribution and liver lesions	Operations	
	Drainage group (n = 48)	Non-drainage group (n = 43)
Left lobe stones, parenchymal atrophy and/or fibrosis	Left hemihepatectomy, T-tube drainage (12) Left lateral segmentectomy, T-tube drainage (10) Left hemihepatectomy, choledochojejunostomy (3)	Left hemihepatectomy (12) Left lateral segmentectomy (8)
Right lobe stones, parenchymal atrophy and/or fibrosis	Right hemihepatectomy, T-tube drainage (6) Right posterior lobectomy, T-tube drainage (4) Right hemihepatectomy, hepaticojejunostomy (2)	Right hemihepatectomy (6) Right posterior lobectomy (3)
Bilateral lobe stones, dominantly affected left lobe atrophy and/or fibrosis	Left hemihepatectomy, right intrahepatic duct stone extraction, T-tube drainage (2) Left lateral segmentectomy, right intrahepatic duct stone extraction, T-tube drainage (3) Left hemihepatectomy, right intrahepatic duct stone extraction, choledochojejunostomy (2)	Left hemihepatectomy, right intrahepatic duct stone extraction (4) Left lateral segmentectomy, right intrahepatic duct stone extraction (6)
Bilateral lobe stones, dominantly affected right lobe atrophy and/or fibrosis	Right hemihepatectomy, left intrahepatic duct stone extraction, T-tube drainage (1) Right hemihepatectomy, left intrahepatic duct stone extraction, hepaticojejunostomy (2) Right hemihepatectomy, left intrahepatic duct stone extraction, choledochojejunostomy (1)	Right hemihepatectomy, left intrahepatic duct stone extraction (4)

Apart from intrahepatic lithiasis, all patients have extrahepatic bile duct stones.

MATERIALS AND METHODS

Patient data

From January 2008 to May 2013, 91 patients diagnosed with intrahepatic and extrahepatic lithiasis underwent hepatectomy and biliary tract exploration with or without biliary drainage in our department. Patients were divided into two groups: one that underwent anatomic hepatectomy and biliary tract exploration with biliary internal or external drainage (drainage group, n = 48); and another that underwent anatomic hepatectomy and biliary tract exploration without any biliary drainage (non-drainage group, n = 43).

There were 18 men (37.5%) and 30 women (62.5%), with a mean age of 54.8 years (range: 23-68 years) in the drainage group. There were 17 men (39.5%) and 26 women (60.5%), with a mean age of 59.3 years (range: 28-71 years) in the non-drainage group. The main symptoms of patients with hepatolithiasis were abdominal pain, fever, and jaundice. A history of right upper quadrant pain was present in all cases, and jaundice in 20 patients (41.7%) in the drainage group and 17 (39.5%) in the non-drainage group.

All cases were evaluated with routine investigations including full blood counts, liver function tests, and coagulation screening. Preoperative diagnosis was based on clinical presentation and imaging technologies, such as ultrasonography, spiral three-phase computed tomography, endoscopic retrograde cholangiopancreatography, and magnetic resonance cholangiography. Indications for liver resection were parenchymal atrophy, intrahepatic biliary stenosis and unilobular severe liver fibrosis.

Surgical procedure

All patients underwent cholecystectomy, except 16 patients who had previous cholecystectomy. Anatomic hepatectomy was performed in all patients in both groups. The CBD was opened through a supraduodenal vertical incision. Stones in the CBD and residual liver were removed by saline flushing. Flexible choledochoscopy was used to extract residual stones and observe the intrahepatic and extrahepatic bile ducts for determination of biliary stricture and dilatation. Function of the sphincter of Oddi was determined by manometry of the CBD in the non-drainage group. If there were no intrahepatic and extrahepatic residual stones, no extrahepatic biliary stricture, and the pressure of CBD was < 12 cmH_2O, primary closure of the CBD without biliary drainage was performed in the non-drainage group. Interrupted 4/0 or 5/0 Prolene sutures were used to complete primary closure of the CBD. In the non-drainage group, dexamethasone and anisodamine were intravenously injected 2-3 d after the operation to prevent postoperative retrograde infection due to intraoperative bile duct irrigation, and to maintain relaxation of the sphincter of Oddi, respectively. In the drainage group, T-tube drainage or creation of a bilioenteric anastomosis was performed after hepatectomy and biliary tract exploration. A sub-hepatic drainage tube was placed in all patients in both groups. T-tube cholangiography was performed on postoperative day 10 in all T-tube-drained patients. Once CBD clearance was confirmed and there was a free flow of contrast agent, the T-tube was removed 4 wk after the operation. Liver function was re-examined 3 and 7 d after the operation and computed tomography or ultrasound B detection was performed before discharge. Calculus distribution, liver lesions and operations are presented in Table 1. If no postoperative complications occurred, patients were discharged once the peritoneal drain was removed and the incision in the abdominal wall healed. Postoperative complications

Table 2 Postoperative complications, hospital stay and costs *n* (%)

Complication	Drainage group (*n* = 48)	Non-drainage group (*n* = 43)	*P* value
Residual stones	7 (14.6)	4 (9.3)	0.329
Bile leakage	7 (14.6)	6 (13.9)	0.586
Pancreatitis	2 (4.2)	2 (4.7)	0.649
Cholangitis	13 (27.1)	9 (20.9)	0.331
T-tube dislocation	1 (2.1)	0	0.527
Postoperative hospital stay (d)	15.4 ± 2.1	11.2 ± 2.8	0.000
Postoperative costs (yuan)	32 933.3 ± 6235.1	29 325.6 ± 5668.2	0.005

Postoperative hospital stay and costs were tested by Student's *t* test. Other variables were tested by Fisher's exact test or χ^2 test.

including bile leakage, jaundice, cholangitis, pancreatitis and T-tube dislocation were observed and compared between the two groups. Bile leakage was defined as bilirubin concentration in the drain fluid at least three times the serum bilirubin concentration on or after postoperative day 3, or as the need for radiological or operative intervention resulting from biliary collection or bile peritonitis[24]. Diagnosis of cholangitis was made by the presence of abdominal pain, jaundice and/or fever. Hospital stay and costs varied from one patient to another in that different patients received different medication due to different preoperative conditions. Postoperative hospital stay and costs were only affected by the modality of operation and clinical outcome of individuals, thus directly reflecting the different values of different operations between the two groups. Parameters of postoperative hospital stay and costs were used in this study.

All patients received regular follow-up assessments every 6 mo. Mean follow-up was 35.3 mo, ranging from 12 to 64 mo.

Statistical analysis

Continuous variables are presented as the mean ± SD. The data were analyzed using SPSS for Windows version 13.0 (SPSS Inc., Chicago, IL, United States). Fisher's exact test or χ^2 was used for categorical variables to calculate frequencies and percentages among the groups. Student's *t* test was applied for continuous variables to compare the means (two-tailed) with median and range among the groups. $P < 0.05$ was considered statistically significant.

RESULTS

There were no significant differences in the demographic characteristics and clinical presentations between the two groups. The surgical methods in both groups are presented in Table 1. There was no surgical mortality in either group. Postoperative complications and hospital stay are compared between the two groups in Table 2. Compared to intrahepatic and extrabiliary drainage, hepatectomy with primary closure of the CBD (non-drainage) did not increase the incidence of complications, including residual stones, bile leakage, pancreatitis and cholangitis. Seven cases (14.6%) of residual stones were found in the drainage group and four cases (9.3%) in the non-drainage group. Bile leakage was found in seven patients (14.6%) in the drainage group and six (13.9%) in the non-drainage group. In the drainage group, there was one case of T-tube dislocation 10 d after the operation, which responded well to conservative treatment. Transient acute pancreatitis developed in two patients (4.2%) in the drainage group and two (4.7%) in the non-drainage group. Of the two pancreatitis patients in the non-drainage group, one had pancreatitis combined with pancreatic abscess that required percutaneous drain insertion for 2 wk. Cholangitis was found in 13 patients (27.1%) in the drainage group and nine (20.9%) in the non-drainage group. As shown in Table 2, median postoperative hospital stay was shorter in the non-drainage group than in the drainage group (11.2 ± 2.8 d *vs* 15.4 ± 2.1 d, $P = 0.000$). The average postoperative cost of treatment was lower in the non-drainage group than in the drainage group (29 325.6 ± 5668.2 yuan *vs* 32 933.3 ± 6235.1 yuan, $P = 0.005$).

DISCUSSION

Choledochotomy followed by T-tube drainage is a traditional surgical treatment for extrahepatic lithiasis[25,26]. Recently, primary closure of the CBD has been proposed as a safe alternative to T-tube placement after both laparoscopic choledochotomy and open choledochotomy in extrahepatic lithiasis[27]. Therefore, the occurrence of postoperative complications related to T-tube placement, such as bile leak, biliary tract infection, dehydration and electrolyte disturbance has been significantly reduced. The patients without T-tube drainage feel more comfortable than those with the T-tube. Apart from T-tube drainage, bilioenteric anastomosis has also been considered a safe and effective method for the treatment of choledocholithiasis and hepatolithiasis[9,28]. However, biliary reflux, and gastrointestinal dysfunction often occur after choledochojejunostomy and hepaticojejunostomy[13,20,21,29]. Recurrence of symptoms in patients with choledochojejunostomy and hepaticojejunostomy showed that this may not be the ideal solution for both intrahepatic and extrahepatic lithiasis. Some studies have evaluated the long-term results of liver resection with or without hepaticojejunostomy for the treatment of primary intrahepatic lithiasis[20]. However, so far, there have been no attempts to evaluate the therapeutic impact of hepatectomy and biliary tract exploration without biliary drainage on intrahepatic lithiasis combined with extrahepatic lithiasis. We performed a retrospective study of hepatectomy and biliary tract exploration without biliary internal or external

drainage for treatment of hepatolithiasis combined with choledocholithiasis. The patients recovered well if there were no residual stones, no extrahepatic biliary stricture, and ⩽ 12 cmH_2O pressure in the CBD. Postoperative complications including residual stones, bile leakage, pancreatitis and cholangitis were equivalent in the drainage and non-drainage groups. Postoperative hospital stay and costs were significantly less in the non-drainage group than in the drainage group. Additional biliary drainage was not necessary for all patients with intrahepatic and extrahepatic calculi, thus avoiding unnecessary discomfort and extra costs.

The principles of definitive surgery for hepatolithiasis comprise complete removal of lesions, establishment of satisfactory drainage of the affected segments of the biliary tree and prevention of recurrence[30,31]. Here, removal of lesions plays a crucial role in treatment of hepatolithiasis. The lesions of hepatolithiasis include stones, stricture, dilation, and affected hepatic tissues. Hepatectomy, especially anatomic hepatectomy, is the optimized method for this condition, which completely removes diseased bile duct and its drainage area, thus reducing the risk of long-term recurrence of stones, and may also prevent the complication of cholangiocarcinoma[13,15,31-37]. Anatomic hepatectomy should be considered as first-line treatment of regional hepatolithiasis.

We performed anatomic hepatectomy and biliary tract exploration, thus completely removing intrahepatic and extrahepatic stones, bile duct stricture, and atrophic or fibrous liver lesions. We explored the biliary tract using choledochoscopy and determined the function of the sphincter of Oddi by manometry of the CBD. Primary closure of the CBD without any biliary drainage was only performed in circumstances in which intrahepatic and extrahepatic stones were completely removed, extrahepatic biliary stricture did not exist, and the pressure of CBD was in the normal range. We measured the pressure of CBD using a scale-marked transparent tube. If the function of the sphincter of Oddi was normal and drained in an unobstructed manner, the liquid level inside the tube decreased smoothly and finally fluctuated in the normal range. The sphincter of Oddi function was preserved so that the rate of postoperative recurrence of cholangitis was lower than in patients without preservation of sphincter of Oddi function. Other studies have also indicated that long-term results of procedures that preserve the sphincter of Oddi have lower rates of postoperative recurrent cholangitis than those without preservation of the sphincter of Oddi[10,19,38].

In the non-drainage group in our study, patients with and without dilated CBD recovered uneventfully. So the CBD diameter is not a prerequisite for the operation without biliary drainage, in that normal CBD diameter might not increase the risk of bile duct stricture and bile leakage. On the contrary, normal CBD diameter implies normal papillary function and an unobstructed distal segment of the CBD. Compared to the diameter of the CBD, sufficient blood supply to the CBD is more important in preventing postoperative bile duct stricture and bile leakage. Furthermore, in the non-drainage group, dexamethasone and anisodamine were intravenously injected 2-3 d after the operation. Hence, postoperative papillary edema was alleviated and the sphincter of Oddi remained relaxed to some extent, thus guaranteeing surgical success. In the non-drainage group, patients with preoperative jaundice recovered uneventfully. The rate of postoperative leakage and jaundice in the non-drainage group was similar to that in the drainage group. Thus, we conclude that drainage is not necessary if jaundice can be determined as obstructive jaundice due to extrahepatic stones. Considering the residual stones, we should be cautious to perform such operation in patients with multiple stones in both lobes of the liver. If unilateral intrahepatic stones, and atrophic or fibrous lesions of the liver are completely removed by hepatectomy, and the contralateral intrahepatic stones are completely extracted by choledochoscopy, hepatectomy with primary closure of the CBD can still be performed.

COMMENTS

Background

Surgical treatment achieves good results for intrahepatic and extrahepatic lithiasis. However, to date, there have been no attempts to evaluate the therapeutic impact of hepatectomy and biliary tract exploration without biliary drainage on intrahepatic lithiasis combined with extrahepatic lithiasis.

Research frontiers

This study showed that hepatectomy followed by choledochoendoscopic stone extraction without biliary drainage in selected patients is safe and effective for treatment of hepatolithiasis combined with choledocholithiasis. Additional biliary drainage is not necessary for all patients with intrahepatic and extrahepatic calculi, thus avoiding unnecessary discomfort and extra costs.

Innovations and breakthroughs

After hepatectomy, the authors measured common bile duct (CBD) pressure using a scale-marked transparent tube. If sphincter of Oddi function was normal with unobstructed drainage, the liquid level inside the tube decreased smoothly and finally fluctuated within the normal range. Dexamethasone and anisodamine were intravenously injected 2-3 d postoperatively to prevent retrograde infection due to intraoperative bile duct irrigation, and to maintain relaxation of the sphincter of Oddi, respectively. Hence, postoperative papillary edema was alleviated and sphincter of Oddi was maintained in a state of relaxation, thus guaranteeing surgical success.

Applications

Jia CK *et al* performed hepatectomy and biliary tract exploration without biliary internal or external drainage for treatment of hepatolithiasis combined with choledocholithiasis. Patients recovered well if there were no residual stones, no extrahepatic biliary stricture, and ⩽ 12 cmH_2O CBD pressure. Postoperative hospital stay and costs were significantly less in the non-drainage group than in the drainage group. Additional biliary drainage is not necessary for all patients with intrahepatic and extrahepatic calculi, thus avoiding unnecessary discomfort and extra costs.

Terminology

Hepatectomy followed by choledochoendoscopic stone extraction without biliary drainage in selected patients is safe and effective for treatment of hepatolithiasis combined with choledocholithiasis.

Peer-review

This is a retrospective case-control study comparing treatments of intrahepatic stones with extrahepatic components by hepatectomy and CBD exploration with or without drainage.

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