

Laparoscopic hepatectomy for the treatment of pyogenic liver abscess

A retrospective case-control study

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Abstract

Percutaneous catheter drainage is the first-line treatment for pyogenic liver abscess (PLA). Some patients need hepatectomy because of underlying hepatobiliary pathology or unresponsiveness to nonoperative treatment, the traditional method is open hepatectomy (OH). Laparoscopic hepatectomy (LH) for PLA is rarely reported. The purpose of this study is to describe our experience of LH for treating PLA and to compare LH with OH. The medical records of patients who underwent LH for treating PLA were retrospectively analyzed, and the results were compared with those of patients with OH. From January 2015 to December 2021, 61 patients with PLA underwent hepatectomy, and 28 patients who underwent LH (LH group) were compared with 33 patients who underwent OH (OH group). There were no significant differences in the basic data between the 2 groups. Two patients in the LH group were converted to open surgery due to hemorrhage and dense perihepatic adhesions, there was no significant difference between the 2 groups in the operation time (186.2 ± 85.6 vs. 175.9 ± 76.7 minutes, $P = .239$), Institut Mutualiste Montsouris classification, extent of hepatectomy and drainage tube removal time, however, the blood loss (200.0 ± 100.5 vs. 470.9 ± 120.1 mL, $P = .003$), numerical rating scale (5.2 ± 1.8 vs. 9.1 ± 1.6 , $P = .042$), the time to resume oral diet (12.3 ± 6.5 vs. 24.6 ± 10.2 hours, $P = .005$), the ambulant time (20.2 ± 7.3 vs. 40.2 ± 10.8 hours, $P = .010$), incidence of postoperative complications (14.3% vs. 33.3%, $P = .002$), comprehensive complication index (46.2 vs. 60.6, $P = .013$), postoperative hospital stay (8.5 ± 7.3 vs. 13.5 ± 10.2 days, $P = .025$) in the LH group was significantly less than that in the OH group. With experience laparoscopic surgeons, treating PLA by LH is safe and feasible and compares favorably with OH.

Abbreviations: CVP = central venous pressure, IOUS = intraoperative ultrasonography, LH = laparoscopic hepatectomy, OH = open hepatectomy, PCD = percutaneous catheter drainage, PLA = pyogenic liver abscess, RLV = residual liver volume.

Keywords: hemorrhage, laparoscopic hepatectomy, percutaneous catheter drainage, pyogenic liver abscess

1. Introduction

Pyogenic liver abscess (PLA) is a common but serious infectious disease. The annual incidence of PLA is 3.6/100,000 to 18/100,000, which is higher in Southeast Asia than in the United States and other Western countries and is increasing year by year.^[1,2] The common origin of PLA is biliary and hematogenous,^[3] and the possibility of gastrointestinal tumors need to be considered when there are cryptogenic infections.^[4] In China, the main pathogen of PLA is *Klebsiella pneumoniae* (*K. pneumoniae*), accounting for approximately 36.6%, followed by *Escherichia coli* (*E. coli*). In Western countries, the infection rate of *K. pneumoniae* is also increasing year by year.^[3,5] There are no typical symptoms of PLA in the initial stage, and the infection rate of drug-resistant bacteria increases due to the excessive use of antibiotics; PLA also occurs in patients with chronic diseases or malignant tumors,^[3,4] for above reasons, if

PLA is not diagnosed and treated in time, it will lead to sepsis, multiple organ dysfunction syndrome and even death, and the mortality rate of PLA can be as high as 15%.^[1,2,6] The combination of percutaneous catheter drainage (PCD) and antibiotic therapy is the first choice for the treatment of PLA, and the cure rate is over 95%.^[7] However, when conservative treatment of PLA is ineffective or accompanied by underlying hepatobiliary pathology, hepatectomy is needed.^[8,9] According to previous studies, open hepatectomy (OH) for PLA may lead to bacterial dissemination and contamination of the abdominal cavity, and it has a mortality rate of 10.5% to 16%.^[9] In OH for hepatocellular carcinoma complicated by PLA, the mortality rate is as high as 40.9%.^[10]

Laparoscopic hepatectomy (LH) has been widely applied to benign and malignant liver tumors, with the advantages of less trauma, quick recovery and fewer complications.^[11,12] At present, the application of laparoscopy in PLA is mainly in abscess

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drainage,^[13] LH for PLA is rarely reported. Different from the usual situation, patients with PLA have special characteristics, such as systemic inflammatory response syndrome, malnutrition, poor liver function, dense adhesions around the liver, liver tissue hyperemia and edema, which increase the difficulty and risk of surgery and anesthesia. In order to evaluate the safety and feasibility of LH in the treatment of PLA, the blood loss, operation time, conversion rate and the incidence of postoperative complications need to be compared with OH.

2. Materials and methods

This study was approved by the Ethics Committee of Mianyang Central Hospital, and was performed in accordance with the ethical guidelines of the Declaration of Helsinki, all patients signed written informed consent before the operation.

2.1. Patients

This study was a retrospective analysis of the medical records of 61 patients with PLA who met the inclusion and exclusion criteria and who were treated by hepatectomy in our hospital between January 2015 and December 2021, and the review revealed 40 males and 21 females, with a mean age of 53.1 ± 16.2 years. Of the 62 patients, 28 underwent LH (LH group), and 33 underwent OH (OH group).

Inclusion criteria: PLA was not liquefied or cellular, PCD could not be performed, and patients failed conservative treatment; Patients with underlying hepatobiliary pathology; Liver function was classified as Child–Pugh A, and the 15-minute residual rate of indocyanine green (ICG R15) < 10%. Exclusion criteria: The patient was complicated with systemic diseases and could not tolerate the operation; Diffuse liver abscess, involving bilateral liver lobes, and a ratio of residual liver volume (RLV) to standard liver volume $\leq 40\%$.^[14]

2.2. Preoperative assessment

The preoperative management included control of infection with antibiotics, providing adequate calories, improving nutrition,

and restoring fluid and electrolytes and acid-base balance. All patients underwent inflammatory markers (including blood count, C-reactive protein, and procalcitonin), liver and kidney function, coagulation function, electrolytes, blood gas test and blood cultures (prior to antibiotic administration). Color Doppler is useful in assessing the abscess size, location, liquefaction and feasibility of PCD. MRI/CT was performed to assess the pathological changes and liver anatomy (Fig. 1A and B). The hepatic reserve function was evaluated by ICGR15 and the Child–Pugh classification. Three-dimensional computed tomography reconstruction was performed to calculate the RLV and make the surgical plan. The blood sugar of the patients was controlled under 10 mmol/L before surgery. When PLA is secondary to underlying hepatobiliary pathology (such as hepatolithiasis, etc.), if the abscess is liquefied well, preoperative PCD can be performed to remove the pus to facilitate infection control, and then hepatectomy was performed to remove the underlying hepatobiliary pathology.

2.3. Surgical treatment

All patients were under general anesthesia, and the surgery was performed by a senior surgeon. Both in LH and OH, the volume of intravenous fluid was limited, and the central venous pressure (CVP) was controlled below 5 cmH₂O during hepatectomy, and any perihepatic adhesions and ligaments were dissected and the abdominal viscera were detected overall. The intermittent Pringle maneuver (IPM, 15/5 minutes) was performed to control hepatic inflow. The extent of hepatectomy depended on the location of the abscess. Intraoperative ultrasonography (IOUS) was performed to mark the extent of the abscess and important blood vessels. Any spilled pus was aspirated completely in time. The pedicle of the PLA was ligated firstly with an intra-Glissonian or extra-Glissonian approach, the hepatic parenchyma was transected using an ultrasonic scalpel along the ischemia line, at the same time, the section was irrigated with warm normal saline to keep the surgical field clear. The pus inside the abscess was collected for bacterial culture, and the PLA was completely removed. If necessary, residual stones were removed with a

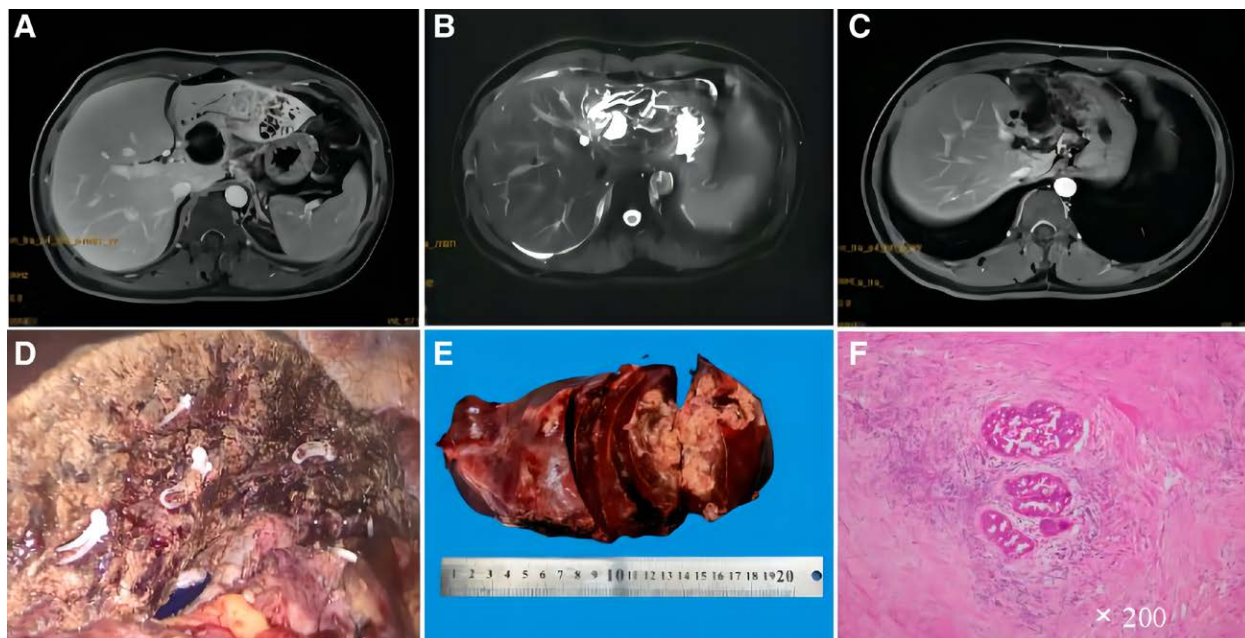


Figure 1. Preoperative and postoperative MRI images, liver section and pathological features of patient with hepatic duct adenocarcinoma and PLA. A: MRI image of a patient with multiple abscesses of the left liver; B: MRI image of abscesses and dilated bile ducts in the same patient; C: MRI image of the patient during follow up, there are no signs of tumor recurrence; D: Hepatic section after left hemihepatectomy; E: The specimen of left hemihepatic and abscesses; F: Pathological examination shows infiltration of tumor cells and inflammatory cells, and the diagnosis is hepatic duct adenocarcinoma and liver abscess.

choledochoscope. One or more drains were placed close to the liver section.

For patients underwent LH for PLA, the patient was placed in a supine position with the legs separated and the head raised. Five ports were placed in a fan-shape around the PLA. The pneumoperitoneum pressure was maintained between 12 and 14 mm Hg. During hepatectomy, obvious oozing from the section was common, at this time, BiClamp forceps was used for hemostasis, the blood vessels smaller than 3 mm could be transected directly by an ultrasonic scalpel, otherwise, they were clamped with a hem-o-lok polymeric clip or titanium clips. The hepatic vein was cut off by an Endo-GIA stapler. After complete removal of the abscess, the liver section was carefully examined for bleeding and biliary fistula (Fig. 1D). Then, the specimen was placed into the retrieval pouch and removed (Fig. 1E).

A right subcostal incision was made for OH, and the procedure of hepatectomy is the same as LH.

2.4. Postoperative care

All patients were treated with antibiotics according to the pus culture results and were also provided with nutritional support. The internal environment, liver and kidney functions were monitored, and the blood glucose was controlled. Chest CT and abdominal CT were performed routinely 3 days after the operation to determine whether there was pleural effusion, pulmonary infection, or intraabdominal collections. After exclusion of infection and bleeding, the drain could be removed. The patients were followed up in an outpatient clinic at 1, 3 and 6 months, and yearly thereafter, liver function, color Doppler or CT was performed during the follow-up.

2.5. Statistical analysis

All data were analyzed using SPSS statistical software for Windows (ver. 23.0; SPSS Inc, Chicago, IL). All data are presented as the mean (standard deviation), median, or number (% incidence). Continuous variables were compared using Student’s *t* test, and categorical variables were compared using the χ^2 test. *P* < .05 was considered statistically significant.

3. Results

3.1. Comparison the basic data between LH group and OH group

In the LH group, the mean age was 54.2 ± 10.5 years, and the majority of the patients were males (19/28). The BMI was 20.9 ± 3.1 kg/m². Most patients had fever (24/28), and 1 of the patients had endophthalmitis. Of the comorbidities, diabetes mellitus (13/28) and hepatolithiasis (12/28) were the most common. Three patients were complicated with malignant tumors. One of the patients suffered recurrent PLA and received nonoperative treatment at another hospital for 7 months, PCD was performed 3 times, laparoscopic left hepatectomy was finally performed in our department, which was diagnosed as left hepatic duct adenocarcinoma by postoperative pathologic examination (Fig. 1F). Another HCC patient was infected after radiofrequency ablation with skin sinus formation, PCD failed, and surgery was performed 6 months later. Preoperative PCD was performed in 6 patients to control infection. A total of 60.7% of the PLAs were located in the left lobe of liver, and 14.3% were located in the middle lobe of liver. The mean PLA size was 9.6 ± 4.1 cm. The median time from onset of symptoms to treatment was 9 days, and the

median time from treatment to operation was 11 days. The results of pus culture showed that *K. pneumoniae* was the most common pathogen (42.9%), followed by *E. coli* (25.0%). Also, 57.1% and 42.9% of the patients had the American Society of Anesthesiologists classification grades of II and III, respectively. The basic data of the patients in the LH group compared with those in the OH group, the distribution of sex, clinical manifestations, concomitant diseases, the number of patients who underwent preoperative PCD, the location of the PLA, the size of PLA, the median time from onset of symptoms to treatment and the median time from treatment to operation, the culture results of pus, and American Society of Anesthesiologists classification were not significantly different between the 2 groups (Table 1).

Table 1
Basic data of patients with pyogenic liver abscesses.

Variables	LH group (n = 28)	OH group (n = 33)	P-value
Gender, n (%)			.852
Male	19 (67.9)	21 (63.6)	
Female	9 (32.1)	12 (36.4)	
Age, years, mean ± SD	54.2 ± 10.5	52.8 ± 8.7	.781
BMI, kg/m ²	20.9 ± 3.1	21.7 ± 2.8	.883
Clinical manifestations, n (%)			.365
Fever	24 (85.7)	30 (90.9)	
Abdominal pain	15 (53.6)	19 (57.6)	
Jaundice	4 (14.3)	5 (15.2)	
Septic shock	2 (7.1)	4 (12.1)	
Pulmonary infection	3 (10.7)	3 (9.1)	
Klebsiella pneumoniae	1 (3.6)	0 (0.0)	
endophthalmitis			
Concomitant diseases, n (%)			.217
Hepatolithiasis	12 (42.9)	16 (48.4)	
Diabetes mellitus	13 (46.4)	14 (42.4)	
Hypertension	7 (25.0)	9 (27.3)	
Hepatocellular Carcinoma	2 (7.1)	2 (6.1)	
Mucinous	1 (3.6)	2 (6.1)	
cystadenocarcinoma			
Preoperative percutaneous drainage, n (%)	6 (21.4)	8 (24.2)	.527
Location of the PLA, n (%)			.331
Left lobe of liver	17 (60.7)	18 (54.5)	
Right lobe of liver	7 (25.0)	9 (27.3)	
Middle lobe of liver	4 (14.3)	6 (18.2)	
PLA size, cm	9.6 ± 4.1	8.7 ± 3.3	.895
Time from onset of symptoms to treatment (d), median	9 (1-21)	11 (1-18)	.651
Time from treatment to operation (d), median	11 (3-210)	7 (5-195)	.741
Initial laboratory values, mean ± SD			.443
WBC count (×10 ⁹ /L)	12.6 ± 5.3	11.8 ± 7.1	
PLT (×10 ⁹ /L)	180.6 ± 95.2	165.5 ± 104.8	
HGB (g/L)	118.3 ± 49.2	126.6 ± 52.1	
PCT (μg/L)	8.2 ± 3.3	6.5 ± 4.1	
TBIL (μmol/L)	18.9 ± 10.4	22.6 ± 11.8	
ALB (g/L)	34.2 ± 8.5	30.8 ± 9.3	
Pus culture, n (%)			.158
<i>K. pneumoniae</i>	12 (42.9)	15 (45.5)	
<i>E. coli</i>	7 (25.0)	7 (21.2)	
Other bacteria	4 (14.3)	5 (15.2)	
Undetected	5 (17.9)	6 (18.2)	
ASA classification, n (%)			.427
II	16 (57.1)	18 (54.5)	
III	12 (42.9)	15 (45.5)	

ASA = American Society of Anesthesiologists, BMI = body mass index, PLA = pyogenic liver abscesses.

3.2. Perioperative outcomes

In the LH group, according to the Institut Mutualiste Montsouris classification,^[15] grade I, II and III were 32.1%, 17.9% and 50%, respectively. The mean vascular clamping time was 40.7 ± 20.5 minutes, the mean operation time was 186.2 ± 85.6 minutes, and the mean intraoperative blood loss was 200.0 ± 100.5 mL. Two patients required blood transfusion, and 2 patients were converted to open surgery due to hemorrhage and dense adhesions around the liver. Most patients resumed an oral diet on the first postoperative day, the mean time to resume an oral diet was 12.3 ± 6.5 hours, the postoperative pain was well controlled, the mean numerical rating scale (NRS) was 5.2 ± 1.8 , and the median time of drainage tube removal was 4.2 (2–9) days. Most patients got out of bed early after surgery, and the mean time was 20.2 ± 7.3 hours. Postoperative complications occurred in 4 patients, including subphrenic abscess, grade B bile leakage,^[16] pleural effusion, and acute renal function in 1 patient each. Among them, the patients with subphrenic abscess and pleural effusion needed ultrasound-guided PCD, and the patient with acute renal failure was cured by continuous renal replacement therapy. The mean postoperative hospital stay was 8.5 ± 7.3 days.

In terms of the surgical characteristics, the Institut Mutualiste Montsouris classification, the mean vascular clamping time, the total operation time and the extent of hepatectomy were similar in the LH group and OH group. However, the number of transfusions and mean blood loss in the LH group was significantly less than that the OH group (Table 2).

In terms of postoperative recovery, the mean time to resume oral diet, ambulant time, numerical rating scale, and postoperative hospital stay in LH group was significantly less than that in OH group. The median time of drainage tube removal was similar in the 2 groups. Complications occurred in 10 (33.3%) patients in the OH group, and all complications were cured by conservative treatment. PCD was required in 1 patient with a subphrenic abscess, and a patient with acute liver failure (grade B) was cured by an artificial liver support system.^[17] The overall complication rate, Clavien-Dindo classification, comprehensive complication index in the LH group was significantly lower than that in the OH group. According to the subgroup analysis, the rate of incision infection and pulmonary infection was significantly lower in the LH group than those in the OH group; however, there was no significant difference in the incidence of other complications, and there were no deaths in both groups (Table 3).

Table 2
Surgical characteristics of LH group and OH group.

Variables	LH group (n = 28)	OH group (n = 33)	P-value
IMM classification, n (%)			.452
I, Low	9 (32.1)	10 (30.3)	
II, Intermediate	5 (17.9)	4 (12.1)	
III, High	14 (50.0)	19 (57.6)	
Vascular clamping time, min	40.7 ± 20.5	36.2 ± 22.7	.308
Blood loss (mL)	200.0 ± 100.5	470.9 ± 120.1	.003
Operation time (min)	186.2 ± 85.6	175.9 ± 76.7	.239
Intraoperative blood transfusions, n (%)	2(7.1)	5(15.2)	.002
Extent of hepatectomy, n (%)			.373
Left lateral sectionectomy	9 (32.1)	10 (30.3)	
Left hepatectomy	5 (17.9)	4 (12.1)	
Central hepatectomy	5 (17.9)	8 (24.2)	
Right posterior sectionectomy	3 (10.7)	4 (12.1)	
Right hepatectomy	6 (21.4)	7 (21.2)	
Combined caudate lobectomy	5 (17.9)	5 (15.2)	
Convert to open surgery	2 (7.1)	-	-

IMM = Institut Mutualiste Montsouris.

Table 3
Comparison of postoperative recovery of LH group and OH group.

Variables	LH group (n = 28)	OH group (n = 33)	P-value
NRS	5.2 ± 1.8	9.1 ± 1.6	.042
The time to resume oral diet, h, mean \pm SD	12.3 ± 6.5	24.6 ± 10.2	.005
Time of drainage tube removal, median	4.2 (2–9)	3.1 (2–11)	.815
The ambulant time, h, mean \pm SD	20.2 ± 7.3	40.2 ± 10.8	.010
Postoperative complication, n (%)	4 (14.3)	10 (30.3)	.002
Pulmonary infection	0 (0.0)	3 (9.1)	.015
Subphrenic abscess	1 (3.6)	1 (3.0)	.827
Bile leakage	1 (3.6)	0 (0.0)	.203
Incisions infection	0 (0.0)	4 (12.1)	.008
Pleural effusion	1 (3.6)	1 (3.0)	.891
Acute liver failure	0 (0.0)	1 (3.0)	.174
Acute renal failure	1 (3.6)	0 (0.0)	.189
Clavien-Dindo classification, n (%)			.008
Grade I	1 (3.6)	4 (12.1)	
Grade II	0 (0.0)	3 (9.1)	
Grade IIIa	3 (10.7)	3 (9.1)	
CCI	46.2	60.6	.013
Postoperative hospital stay (d)	8.5 ± 7.3	13.5 ± 10.2	.025
Pathological findings			.581
Pyogenic liver abscess	13 (46.4)	13 (39.4)	
Hepatolithiasis	12 (42.9)	16 (48.4)	
Hepatocellular Carcinoma	2 (7.1)	2 (6.1)	
Mucinous cystadenocarcinoma	1 (3.6)	2 (6.1)	
Follow-up results, n (%)			
Follow-up time, mean \pm SD	31.2 ± 10.2	28.5 ± 11.6	.567
Follow-up rate, n (%)	23 (82.1)	28 (84.8)	.617

CCI = comprehensive complication index, NRS = numerical rating scale.

In LH group, the mean follow-up time was 31.2 ± 10.2 m, and the follow-up rate was 82.1%, 1 patient with bile duct adenocarcinoma had intrahepatic metastasis 7 months after surgery and died 4 months later. In OH group, the mean follow-up time was 28.5 ± 11.6 m, and the follow-up rate was 84.8%, which were similar in the LH and OH groups. Color ultrasound, CT (Fig. 1C), tumor markers (CEA, ca199, AFP) and blood glucose were examined every 3 to 6 months. One patient in the OH group had poor postoperative blood glucose control and abscess recurrence, which was cured by PCD.

4. Discussion

There are 6 origins for PLA, namely, biliary, portal vein, hepatic artery, direct invasion, open wound and cryptogenic. Among them, biliary origin is the most common, and the underlying hepatobiliary pathology includes hepatolithiasis, bile duct tumor or strictures.^[3] The number of PLAs of arterial origin has increased in recent years due to invasive procedures and the application of immunosuppressants and the increased incidence of diabetes, all of which impair immune function.^[1] Cryptogenic PLA accounts for approximately 18% to 66% of PLA cases, and the possibility of gastrointestinal malignancy should be considered in these patients, especially elderly patients.^[4]

PCD is the preferred treatment for PLA.^[2,7] However, PCD cannot remove the cause of the PLA when there is underlying hepatobiliary pathology, and hepatectomy is needed. In this study, a patient with recurrent PLA experienced a timeline of 7 months from the initial onset to hepatectomy, and the postoperative pathological examination diagnosed the lesion as bile duct cystadenocarcinoma. Therefore, for patients with recurrent or cryptogenic PLA, the cause should be actively determined to avoid a misdiagnosis. Additionally, hepatectomy should also be considered for honeycomb-like or nonliquefied PLA that are difficult to treat with PCD, and sepsis is difficult to correct.^[8,9,18] According to Hsieh et al.^[9] hepatectomy could

improve the outcome of patients with PLA when the APACHE II score is > 15. Hepatectomy for PLA can not only remove inflammatory and necrotic tissue but also remove underlying hepatobiliary pathology, which could be helpful in controlling infection-related complications, such as renal failure, respiratory failure or disturbance of consciousness, reducing the duration of antibiotics and the possibility of superinfection.^[9,19]

LH has been widely used for the management of hepatolithiasis and benign and malignant liver tumors, compared with OH, LH has the advantages of less trauma, faster postoperative recovery, and fewer complications.^[11,12,20] In the treatment of malignant liver tumors, the curative effect of LH is equivalent to that of OH.^[21,22] In our study, 61 patients with PLA of different causes and different locations underwent hepatectomy, of which 28 patients underwent LH, and 33 patients underwent OH. There was no significant difference in the operation time between the 2 groups, but the intraoperative blood loss, postoperative hospital stay, numerical rating scale, and overall postoperative complication rate in the LH group were significantly lower than those in the OH group. In this study, the incidence of postoperative complications in the LH and OH groups was 14.3% and 33.3%, respectively, and there were no deaths. The subgroup analysis showed that the number of postoperative infection-related complications in the OH group were significantly higher than those in the LH group, which might be related to greater trauma in the OH group. Liver and kidney failure are common causes of death in patients with PLA after surgery.^[9,10] In the OH group, 1 patient developed liver failure and was cured by an artificial liver support system, while in the LH group, 1 patient developed renal failure and was cured by continuous renal replacement therapy. The incidence of postoperative complications in this article seems to be higher than that of hepatectomy for noninfectious diseases.^[23,24]

Actively improving the patient's general condition and accurately assessing the extent of the PLA before surgery are important measures to reduce the perioperative risk of patients. Color Doppler ultrasound, CT and MRI examinations were used to determine the location, size, and extent of the abscess, as well as to determine whether the lesion was associated with malignant tumors. ICGR15 and three-dimensional computed tomography were used to evaluate the hepatic reserve function and RLV. A total of 38.1% to 44.3% of the PLA patients were complicated with diabetes mellitus,^[25] which was 40% in this study and was significantly higher than those with other liver diseases.^[11,12] Poor blood glucose control leads to decreased neutrophil activity, promotes pathogen growth in the liver tissue, and increases the difficulty of infection control, therefore, the patient's perioperative blood glucose should be closely monitored and controlled.^[26] Malnutrition, inflammatory syndrome, water and electrolyte imbalances, hemodynamic disorders, liver and kidney dysfunction and other complications increase the risk of surgery and anesthesia. Broad-spectrum antibiotics should be actively used, based on the sensitivity tests to control infection, the nutritional support should be strengthened, and the blood glucose should be controlled to reduce the risk of surgery and anesthesia. For patients with underlying hepatobiliary pathology, preoperative PCD is feasible, and hepatectomy can be performed after the patient's general condition improves. In mainland China, more than 80% of the PLA cases are caused by *K. pneumoniae*, which has the characteristics of extrahepatic metastatic infection, 5% of *K. pneumoniae*-related PLA cases are combined with endophthalmitis and nervous system infections, the early symptoms of endophthalmitis and nervous system infections are not typical, and the mortality rate can be as high as 90%.^[27] The 2 patients with endophthalmitis in this study were cured by multidisciplinary treatment.

The general and local conditions of the liver in patients with PLA are significantly different from those in patients with non-infectious liver disease, and LH is extremely challenging for both the surgeon and the anesthesiologist. LH for PLA requires

skilled techniques and close cooperation of assistants to clean up the blood and pus in time to keep the surgical field clear. IOUS is widely used in liver cancer and hepatolithiasis.^[20,28] When using LH for the treatment of PLA, IOUS can accurately locate important blood vessels and abscess boundaries, can be used to guide the plane of liver resection, and to avoid abscess rupture and residue. Ligation of the hepatic pedicle where the abscess is located cannot only determine the section of the ischemic line but also can reduce the probability of bacteria entering the blood. Separating adhesions around the PLA is 1 of the difficulties in surgery, especially in patients with a long course of disease. PLA often has dense adhesions with surrounding organs, such as the diaphragm, inferior vena cava, and gastrointestinal tract, as a result, the anatomical structure is unclear, and adjacent organs may be injured during the operation, resulting in serious complications, such as pneumothorax, organ perforation, and massive hemorrhage. Two patients in the LH group were converted to open surgery due to dense adhesions and hemorrhage. Hepatectomy for the treatment of PLA via the anterior approach, which allows for preferentially dissecting the liver tissue and then separating the adhesion around the liver, can reduce the compression of the liver and reduce the bleeding during separation of the adhesion, which is in line with the principle of sterility and has less influence on the hemodynamics and residual liver function.^[29] Another difficulty for LH in treating PLA is the effective control of intraoperative bleeding. The main causes of bleeding are as follows: extensive oozing on the wound surface during adhesion separation; bleeding in the process of hepatectomy because of swelling and congestion of liver tissue; to maintain the patient's hemodynamic stability, the anesthesiologist may infuse too many fluids, leading to high CVP, which results in increased bleeding from the hepatic vein. For oozing in the surgical area, Biclamp was used for hemostasis; blood vessels with diameters less than 3 mm were slowly coagulated with an ultrasonic scalpel;^[30] otherwise, they were clipped with a hem-o-lok or titanium clip; when the broken end of the vessel retracted into the liver parenchyma and hemostasis was difficult, the vessel should be sutured; blocking the inflow blood of the liver and controlling the CVP below 5 cmH₂O can significantly reduce the intraoperative bleeding.^[31]

This article has the following limitations: This is a retrospective study, and there may be some confounding factors leading to confounding bias; This study is a regional study in a single center, due to the different demographic characteristics and etiology in other regions, its representativeness needs further external verification, therefore, a multicenter, prospective, controlled, randomized study is necessary.

In conclusion, LH is an important method for PLA in which PCD is ineffective or impossible, it could remove the underlying hepatobiliary pathology and PLA thoroughly, compared with OH, LH for PLA could reduce surgical trauma and postoperative complications. Although LH for PLA is extremely challenging, by wit experience laparoscopic surgeons, it is safe and feasible to perform selectively.

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