

# World Journal of *Gastroenterology*

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## Observational Study

# Impact of B-mode-ultrasound-guided transhepatic and transperitoneal cholecystostomy tube placement on laparoscopic cholecystectomy

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**Author contributions:** Liu P performed percutaneous cholecystostomy and laparoscopic cholecystectomy, collected the data, performed the statistical analysis and drafted the manuscript; Yang YX designed the study and revised the manuscript; Liu C, Wu YT, Zhu JY, Zhao WC, Li JB and Zhang H performed percutaneous cholecystostomy and laparoscopic cholecystectomy, collected the data and coordinated the work; All authors read and approved the final paper.

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## Abstract

### BACKGROUND

B-mode-ultrasound-guided percutaneous cholecystostomy (PC) may be performed by a transhepatic or transperitoneal approach, called percutaneous transhepatic gallbladder drainage (PHGD) and percutaneous transperitoneal gallbladder drainage (PPGD), respectively. We compared the impact of PC related to the route of catheter placement on subsequent laparoscopic cholecystectomy (LC).

### AIM

To compare the impact of PC related to the route of catheter placement on subsequent LC.

### METHODS

We retrospectively studied 103 patients with acute calculous cholecystitis who underwent scheduled LC after PC between January 2010 and January 2019. Group I included 58 patients who underwent scheduled LC after PHGD. Group II included 45 patients who underwent scheduled LC after PPGD. Clinical outcomes were analyzed according to each group.

### RESULTS

Baseline demographic characteristics did not differ significantly between both groups ( $P > 0.05$ ). Both PHGD and PPGD were able to quickly resolve cholecystitis sepsis. Group I showed significantly higher efficacy than group II in terms of lower pain score during puncture (3.1 vs 4.5;  $P = 0.001$ ) and at 12 h follow-up (1.5 vs 2.2;  $P = 0.001$ ), lower rate of fever within 24 h after PC (13.8% vs 42.2%;  $P = 0.001$ ), shorter operation duration (118.3 vs 139.6 min;  $P = 0.001$ ), lower amount of intraoperative bleeding (72.1 vs 109.4 mL;  $P = 0.001$ ) and shorter length

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of hospital stay (14.3 d *vs* 18.0 d;  $P = 0.001$ ). However, group II had significantly lower rate of local bleeding at the PC site (2.2% *vs* 20.7%;  $P = 0.005$ ) and lower rate of severe adhesion (33.5% *vs* 55.2%;  $P = 0.048$ ). No significant differences were noted between both groups regarding the conversion rate to laparotomy, rate of subtotal cholecystectomy, complications and pathology.

## CONCLUSION

B-mode-ultrasound-guided PHGD is superior to PPGD followed by LC for treatment of acute calculous cholecystitis, with shorter operating time, minimal amount of intraoperative bleeding and short length of hospital stay.

**Key Words:** Acute calculous cholecystitis; Percutaneous transhepatic gallbladder drainage; Percutaneous transperitoneal gallbladder drainage; Laparoscopic cholecystectomy; B-mode ultrasound; Acute cholecystitis

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**Core Tip:** B-mode-ultrasound-guided percutaneous cholecystostomy (PC) may be performed by a transhepatic or transperitoneal approach, called percutaneous transhepatic gallbladder drainage (PHGD) and percutaneous transperitoneal gallbladder drainage (PPGD), respectively. However, few studies have reported the effects of the two different approaches on laparoscopic cholecystectomy (LC). We compared the impact of PC related to route of catheter placement on subsequent LC. Our results suggested that B-mode-ultrasound-guided PHGD is superior to PPGD followed by LC for treatment of acute cholecystitis (AC). We suggest that PHGD should be chosen in the early stage of AC.

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## INTRODUCTION

Acute cholecystitis (AC) is inflammation of the gallbladder that most commonly occurs as a result of obstruction of the cystic duct by gallstones, and laparoscopic cholecystectomy (LC) is considered to be the most effective management<sup>[1]</sup>. Postoperative mortality rates in LC for high-risk patients such as elderly or critically ill patients have been estimated at 5%-30%. Among these patients, percutaneous cholecystostomy (PC) has been a preferred alternative because this procedure decreases postoperative mortality rates in high-risk patients to 10%-12%<sup>[2]</sup>. In elderly or critically ill patients with AC, PC can be used immediately, and cholecystectomy can be safely performed when the patient's condition improves<sup>[3]</sup>. Kim *et al*<sup>[4]</sup> showed that an elective delayed LC after PC decreases conversion and complication rates in AC, although it increases hospital stay and patients have the inconvenience of a cholecystostomy tube. PC remains a viable option for the treatment of AC with a low complication rate and can be used as a bridge to definitive therapy<sup>[5]</sup>. Meanwhile, one study found that cholecystostomy may cause fibrosis during the healing process, eventually complicating LC<sup>[6]</sup>.

There are two access routes for PC: The transhepatic approach by which the gallbladder is accessed through the surface in contact with the liver, named percutaneous transhepatic gallbladder drainage (PHGD); and the transperitoneal approach through the exposed surface of the gallbladder lined by visceral peritoneum, named percutaneous transperitoneal gallbladder drainage (PPGD). Preprocedural preparation by reviewing patients' radiographic images (to evaluate the anatomy of the gallbladder and to determine the presence of any focal thickenings that could interfere with the procedure) will heavily impact the surgeon's decision to take either approach (transhepatic or transperitoneal). The location of the gallbladder plays a critical role in the choice of the puncture path. In cases where the gallbladder is situated high and the colon cannot be avoided by puncture, then the transhepatic

approach is preferred; however, for the majority of cases, both approaches can be implemented. Each approach has distinct advantages<sup>[7]</sup>. However, few studies have addressed the effect of the two different approaches on LC followed by PC. This study was undertaken to compare surgical results with respect to PHGD and PPGD to determine which is the optimal approach for LC after PC in patients with AC.

## MATERIALS AND METHODS

### **Study group**

This retrospective analysis was conducted on patients with AC who underwent LC after PC at the Sixth Medical Center of the General Hospital of the People's Liberation Army, Beijing, China between January 2010 and January 2019. This study was conducted in accordance with the rules and regulations of the Institutional Review Board of the General Hospital of the People's Liberation Army. We excluded patients with combined common bile duct stones, acute acalculous cholecystitis, direct selection to open surgery, previous upper abdominal surgery, previous chemotherapy or radiotherapy due to another malignancy, unsuspected gallbladder carcinoma and bile duct carcinoma. One hundred and three patients were included and allocated to group I (PHGD,  $n = 58$ ) and group II (PPGD,  $n = 45$ ). The visual analogue scale was adopted for pain grading<sup>[8]</sup>. The following data were collected: (1) Demographic parameters, such as age, sex, body mass index (BMI), history of abdominal surgery, preoperative American Society of Anesthesiologists (ASA) class, the grade of AC and comorbidity; (2) Clinical findings, such as pain scores, temperature, positive Murphy's sign; (3) Laboratory findings, such as leukocytosis, platelet count, alanine transaminase, aspartate aminotransferase, total bilirubin, prothrombin time (PT) and international normalized ratio (INR); (4) B-mode ultrasound findings, such as gallbladder size and wall thickness; and (5) Duration from onset to PC and interval from PC to elective LC.

### **Diagnosis of acute cholecystitis and indications for percutaneous cholecystostomy**

Diagnosis of AC was reviewed according to the Tokyo guidelines<sup>[9]</sup>, which include: (1) Local signs of inflammation: Murphy's sign, right upper quadrant mass/pain/tenderness; (2) Systemic signs of inflammation: fever, elevated C-reactive protein, elevated white blood cell (WBC) count; and (3) Imaging findings characteristic of AC. Indications for PC were moderate (grade II) or severe (grade III) AC with failure to respond to medical treatment for AC and mild (grade I) with the presence of severe comorbidities, such as hypertension, diabetes, arrhythmia, coronary heart disease, chronic obstructive pulmonary disease, cerebral infarction and chronic renal insufficiency.

### **Percutaneous transhepatic gallbladder drainage and percutaneous transperitoneal gallbladder drainage**

All patients underwent routine blood, biochemical and PT tests before the procedures. PHGD and PPGD were performed by a single qualified surgeon under B-mode ultrasound guidance. Under 1% lidocaine, local anesthesia and intramuscular injection of 100 mg dolantin, an 18-gauge puncture needle (Hakko Company, Japan) was advanced transhepatically or transperitoneally into the gallbladder. After placing a guidewire and dilating the track, an 8.5 Fr pigtail catheter (Dawson-Mueller Drainage Catheter, Cook, Bloomington, IN, United States) was positioned with its tip in the gallbladder. Bile was aspirated from most patients for culture. Cholangiography was carried out to confirm that the pigtail catheter was in the correct position within the gallbladder. All patients underwent an X-ray angiographic examination to confirm that the gallbladder drainage tube was in place and not being obstructed. Then, the drainage tube was retained in its place until the cholecystectomy tube was removed at the same time. The procedural details were reviewed: Anatomic approach, procedure duration, bile culture and postprocedural fluoroscopy. The patient's condition after PC was evaluated: Pain score, fever and chills within 24 h after PC, local bleeding at PC site, complications and days from PC to discharge. Due to the limitation of surgical materials, only Seldinger technology is used in our department. Most patients in the PHGD group chose the intercostal puncture point, while most patients in the PPGD group chose the subcostal puncture point.

### **Laparoscopic cholecystectomy**

LC was performed by two experienced surgeons using a three- or four-port technique. This procedure was carried out 4 wk after performing percutaneous cholecystostomy and after the inflammation had completely subsided. A trocar (10 mm) was placed on the upper edge of the umbilicus for inspection, in which a 30° laparoscope was set to observe the gallbladder and its surrounding area. A 10-mm trocar was also placed below the xiphoid bone under direct vision, and the other trocar (5 mm) was placed in the right upper quadrant. Adhesions around the gallbladder were dissected. Subsequently, adhesions of the cystohepatic triangle were separated with the patient's head up in the left lateral position. The gallbladder was stripped off the liver by electrocautery and extracted through the umbilical port. Because there were no quantitative evaluation methods for adhesions, patients were classified as having severe adhesion if the surgeon reported: (1) Difficulty in establishing a critical view of safety; or (2) Difficulty in removing the entire gallbladder from the liver bed. All the other patients were defined as having mild adhesions<sup>[10]</sup>. The decision to convert to subtotal cholecystectomy or open cholecystectomy was made according to the operative situation, including the difficulty of dissection, poor control of intraoperative bleeding and adhesions of Calot's triangle or the liver bed. A drain was routinely inserted in all patients. After LC, data were collected from the patients in the PHGD and PPGD groups, and the following parameters were compared: Duration of operation, amount of intraoperative bleeding, rate of severe adhesion, conversion to subtotal cholecystectomy or laparotomy, postoperative complication rate and length of stay. Follow-up visits in the outpatient surgery clinic were scheduled 1 mo after discharge.

### **Pathological classification**

The pathology and grading of cholecystitis were conducted by assessing inflammatory cell infiltration, mucosal change, abscess formation and wall destruction<sup>[11]</sup>. Resected gallbladder inflammation was classified histologically as acute or chronic. Findings of AC were neutrophil infiltration, edema or ulceration of the mucosal layer and necrosis. The characteristics of chronic cholecystitis were lymph follicle formation, chronic inflammatory cell invasion and fibrosis. All pathological examinations were reviewed by a single experienced pathologist.

### **Statistical analysis**

Statistical analysis was performed using SPSS version 17.0 software (SPSS Inc., Chicago, IL, United States). Continuous data were expressed as mean  $\pm$  standard deviation and analyzed by *t*-test. Categorical data in the study were tested using the  $\chi^2$  test or the continuity correction  $\chi^2$  test.  $P < 0.05$  indicated statistical significance.

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## **RESULTS**

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### **Baseline characteristics**

No significant differences were found between the PHGD and PPGD groups in terms of age, sex, BMI, ASA class, severity criteria and comorbidity. Furthermore, laboratory findings, including WBC count, platelet count, total bilirubin level, liver enzymes, PT, and INR were similar in the two groups. The differences in gallbladder size and wall thickness and interval from PC to elective LC showed no significant differences between the PHGD and PPGD groups (all  $P > 0.05$ ), (Table 1).

### **Clinical results after percutaneous transhepatic gallbladder drainage and PPGD**

There were no significant differences in the groups' procedural details, including procedure duration, bile culture performed, positive bile culture, postprocedural fluoroscopy and days from PC to discharge. There were no major complications, such as severe bleeding, bile leak, bowel injury, abscess formation or pneumothorax; however, the frequency of local bleeding at the PC site was significantly higher in the PHGD group than the PPGD group ( $P = 0.005$ ). No procedure-related deaths were noted. There was a significant correlation between the puncture site and anatomical approach; the PHGD group tended to be intercostal, whereas the PPGD group tended to be subcostal. Patients in the PHGD group had a significantly lower mean pain score both during the procedure (3.1 vs 4.5;  $P = 0.001$ ) and at 12 h during postoperative follow-up (1.5 vs 2.2;  $P = 0.001$ ) compared to patients in the PPGD group. Fever and chills were observed in 27 patients immediately following PC; eight in the PHGD

**Table 1 Demographics, clinical characteristics and laboratory values of patients in the percutaneous transhepatic gallbladder drainage and percutaneous transperitoneal gallbladder drainage groups, *n* (%)**

	PHGD group, <i>n</i> = 58	PPGD group, <i>n</i> = 45	<i>P</i> value
Age	73.8 ± 11.6	74.8 ± 12.2	0.672
Sex, male/female	31/27	24/21	0.991
BMI in kg/m <sup>2</sup>	22.8 ± 0.6	23.1 ± 0.8	0.320
Comorbidity, <i>n</i> (%)	49 (84.5)	41 (91.1)	0.315
Hypertension	29 (50.0)	27 (60.0)	0.312
Diabetes	26 (44.8)	16 (35.6)	0.342
Arrhythmia	4 (6.9)	4 (8.9)	0.997
CHD	21 (36.2)	16 (35.6)	0.946
COPD	3 (5.2)	4 (8.9)	0.427
CI	9 (15.5)	6 (13.3)	0.755
CRI	1 (1.7)	1 (2.2)	> 0.999
Others	10 (17.2)	6 (13.3)	0.105
Previous abdominal surgery, <i>n</i> (%)	10 (17.2)	7 (15.6)	0.819
Appendectomy	3 (5.2)	2 (4.4)	> 0.999
Cesarean	6 (10.3)	3 (6.7)	0.699
Oophorectomy	1 (1.7)	2 (4.4)	0.823
ASA grade average	2.3 ± 0.4	2.3 ± 0.5	0.872
Tokyo Guidelines 2018			0.918
Grade I	5 (8.6)	3 (5.2)	
Grade II	46 (79.3)	37 (82.2)	
Grade III	7 (12.1)	5 (11.1)	
Body temperature in °C	37.4 ± 0.87	37.4 ± 0.90	0.506
Positive Murphy's sign, <i>n</i> (%)	40 (69.0)	34 (75.6)	0.461
Leukocytes counts, ×10 <sup>9</sup> /L	15.8 ± 3.2	15.9 ± 3.0	0.872
PLT, ×10 <sup>6</sup> /L	241.7 ± 70.2	238.2 ± 68.3	0.800
ALT, U/L	53.2 ± 17.9	51.2 ± 18.3	0.579
AST, U/L	60.0 ± 18.9	53.2 ± 20.0	0.080
TB, μmol/L	45.2 ± 24.6	47.8 ± 24.9	0.598
PT in s	13.9 ± 2.0	14.1 ± 2.2	0.631
INR	1.2 ± 0.2	1.3 ± 0.3	0.045 <sup>a</sup>
Gallbladder size in cm	10.6 ± 2.0	10.8 ± 2.2	0.631
Gallbladder wall thickness in mm	6.6 ± 2.2	6.9 ± 2.3	0.503
Duration from onset to PC in h	62.4 ± 11.5	57.6 ± 12.2	0.043 <sup>a</sup>
Interval from PC to elective LC in d	34.5 ± 4.7	33.9 ± 4.2	0.503

Note: All baseline characteristics and clinical data and outcomes did not differ significantly between groups except for the international normalized ratio and duration from onset to PC (<sup>a</sup>*P* < 0.05). PHGD: Percutaneous transhepatic gallbladder drainage; PPGD: Percutaneous transperitoneal gallbladder drainage; COPD: Chronic obstructive pulmonary disease; CHD: Coronary heart disease; CI: Cerebral infarction; CRI: Chronic renal insufficiency; PC: Percutaneous cholecystostomy; LC: Laparoscopic cholecystectomy; INR: International normalized ratio; PT: Prothrombin time; PLT: Platelet; ALT: Alanine transaminase; AST: Aspartate aminotransferase; TB: Total bilirubin; ASA: American Society of Anesthesiology; BMI: Body mass index.

group and nineteen in the PPGD group (Table 2). All patients were operated upon successfully, clinical symptoms and laboratory indicators were relieved and discharge was smooth. Before LC, the drainage tube of all patients was kept in place and unobstructed.

### **Comparison of surgical results of laparoscopic cholecystectomy after percutaneous transhepatic gallbladder drainage and percutaneous transperitoneal gallbladder drainage**

The duration of LC surgery in the PHGD group was  $118.3 \pm 34.7$  min, while it was  $139.6 \pm 37.2$  min in the PPGD group (Table 3). The length of hospital stay of the PHGD group after LC surgery was  $14.3 \pm 4.4$  d, while it was  $18.0 \pm 4.8$  d in the PPGD group. The differences in operation duration and length of hospital stay were significant between the two groups ( $P = 0.001$  for both). Intraoperative bleeding in the PHGD group ( $72.1 \pm 30.5$  mL) was significantly lower than in the PPGD group ( $109.4 \pm 33.6$  mL) ( $P = 0.001$ ). Nine cases in the PHGD group (15.5 %) and eleven (24.4 %) in the PPGD group converted to laparotomy because of severe adhesion of the gallbladder triangle or difficult exposure of the gallbladder; however, the difference was not significant ( $P = 0.256$ ). There were no significant differences in the rate of subtotal cholecystectomy in the PHGD and PPGD groups. The AC to chronic cholecystitis ratio was lower in the PHGD group (37.9%) than the PPGD group (40.0%), but not significantly ( $P = 0.831$ ).

## **DISCUSSION**

The first PC was performed in 1980 for the management of AC and was accomplished with ultrasonic guidance<sup>[12]</sup>. PC may have a role in milder presentations of AC. In patients with grade II AC, PC followed by LC has been shown to have better outcomes compared to emergency cholecystectomy, including lower rates of conversion to open cholecystectomy, less intraoperative bleeding, shorter duration of postoperative abdominal drainage, shorter hospital stay after cholecystectomy, lower incidence of respiratory failure, fewer admissions to the intensive care unit and greater reversal of the pathological process affecting the gallbladder<sup>[13]</sup>. PC can serve as a bridge to surgery until the inflammatory process has subsided<sup>[14]</sup>. Despite conflicting data surrounding indications for PC, there is consensus that if the decision is made to pursue PC, it should be done early<sup>[15]</sup>. Most of the studies have paid more attention to the indications and interval time from PC to LC. To our knowledge, no previous comparative studies have focused on the effect of different puncture approaches of PC on subsequent LC. In our study, there was no significant difference between the two groups for preoperative baseline data. Therefore, the results of the two groups were more reliable.

PC can be performed using either the Seldinger or trocar technique, and both techniques present significant advantages and disadvantages. Despite a small series in the literature showing similar outcomes between the techniques, most authors continue to state that the transhepatic approach is preferred. Their results support the traditional teaching that the transhepatic approach should be preferred to decrease potential complications<sup>[16,17]</sup>. Our study found that the pain index during and 12 h after puncture in the PPGD group was higher than in the PHGD group. Beland *et al*<sup>[18]</sup> found that the pain index of the two groups was the same, and there was no significant difference. The reason may be that in Beland's study, two different Seldinger or trocar techniques were applied in the two groups. In our study, only the Seldinger technology was used in both groups. In the puncture process, there was a process of guidewire replacement. In this process, a small amount of bile leakage to the outside of the gallbladder was not excluded. Therefore, local peritoneal stimulation aggravated the pain. During the 24 h after the operation, the rate of chill and fever in the PPGD group was higher than in the PHGD group.

PC is used for therapeutic purposes if the patient has problematic complications or comorbidity. For such high-risk patients, early surgery (< 3 d) is not recommended, and PC is indicated<sup>[19]</sup>. In our study, we found that the rate of comorbidity in the PHGD and PPGD groups was 84.5% and 91.1%, respectively, and the time to PC was  $62.4 \pm 11.5$  and  $57.6 \pm 12.2$  h, respectively. The two groups of patients were in line with the best indications of PC. Rates of bile duct injury during LC have been estimated between 0.025% and 0.08%<sup>[20-22]</sup>. The rate of common bile duct injury following PC is higher during subsequent cholecystectomy compared to that of the general population. In the study by Altieri *et al*<sup>[23]</sup> of 2998 patients who underwent

**Table 2** Procedural details, postprocedural hospital course and complications in percutaneous transhepatic gallbladder drainage and percutaneous transperitoneal gallbladder drainage groups, *n* (%)

	PHGD group, <i>n</i> = 58	PPGD group, <i>n</i> = 45	<i>P</i> value
Puncture site, subcostal/ intercostal	4/54	44/1	0.001 <sup>b</sup>
Procedure duration in min	6.7 ± 2.1	6.8 ± 2.2	0.693
Bile culture performed, %	20 (43.1)	18 (40.0)	0.565
Bile culture positive, %	19 (32.8)	18 (40.0)	0.447
Postprocedural fluoroscopy, %	45 (77.6)	39 (86.7)	0.239
Pain score			
During puncture	3.1 ± 1.9	4.5 ± 1.7	0.001 <sup>b</sup>
At 12 h follow-up	1.5 ± 0.7	2.2 ± 0.8	0.001 <sup>b</sup>
Fever and chills within 24 h after PC, %	8 (13.8)	19 (42.2)	0.001 <sup>b</sup>
Local bleeding at PC site, %	12 (20.7)	1 (2.2)	0.005 <sup>b</sup>
Days from PC to discharge	4.8 ± 2.2	4.7 ± 2.5	0.830

<sup>b</sup>*P* < 0.01. PHGD: Percutaneous transhepatic gallbladder drainage; PPGD: Percutaneous transperitoneal gallbladder drainage; PC: Percutaneous cholecystostomy.

**Table 3** Comparison of surgical results of laparoscopic cholecystostomy in patients between percutaneous transhepatic gallbladder drainage and percutaneous transperitoneal gallbladder drainage groups, *n* (%)

	PHGD group, <i>n</i> = 58	PPGD group, <i>n</i> = 45	<i>P</i> value
Operative duration in min	118.3 ± 34.7	139.6 ± 37.2	0.001 <sup>b</sup>
Intraoperative bleeding, mL	72.1 ± 30.5	109.4 ± 33.6	0.001 <sup>b</sup>
Conversion to laparotomy, %	9 (15.5)	11 (24.4)	0.256
Subtotal cholecystectomy, %	5 (8.6)	2 (4.4)	0.404
Rate of severe adhesion, mild/ severe complications	26/32	29/16	0.048 <sup>a</sup>
Bile leak	3 (5.2)	4 (8.9)	0.457
Bleeding	1	1	> 0.999
Wound infection	0	1	> 0.898
Pulmonary infection	1	0	> 0.999
Deep vein thrombosis of lower extremity	1	1	> 0.999
Pathology, acute/ chronic	0	1	> 0.898
Hospital length of stay in d	22/36	18/27	0.831
	14.3 ± 4.4	18.0 ± 4.8	0.001 <sup>b</sup>

<sup>a</sup>*P* < 0.05;

<sup>b</sup>*P* < 0.01. PHGD: Percutaneous transhepatic gallbladder drainage; PPGD: Percutaneous transperitoneal gallbladder drainage.

cholecystectomy following PC, 47 (1.6%) patients experienced common bile duct injury. Some studies suggest that risks may be increased further when LC is performed at an early stage after PHGD in high-risk patients<sup>[24]</sup>. El-Gendi *et al*<sup>[13]</sup> and Ke and Wu<sup>[25]</sup> reported good outcomes when LC was performed after waiting 4-6 wk after PHGD. Therefore, most of our patients choose LC at 4 wk after PC.

We found that there was no significant difference between the two groups regarding complications as well as the conversion to open surgery and partial cholecystectomy. We speculate that the conversion rate and the rate of the subtotal cholecystectomy mainly depend on the adhesion of the triangle of the gallbladder and severity of inflammation. This factor is related to inflammation of the gallbladder itself

and has no relationship with the pathway of PC. There were significant differences between the two groups in terms of operation time, postoperative drainage, degree of intraoperative adhesion around the gallbladder and amount of intraoperative bleeding. The possible reasons are as follows. First, compared with the PHGD group, the PPGD group's drainage tube went along the abdominal cavity forming local columnar adhesion around it, which increased the separation time and area. Second, because puncture of the PPGD group only used the Seldinger technique for guidewire replacement, a small amount of bile inevitably overflowed around the gallbladder, which aggravated the inflammatory response of the gallbladder and formed more adhesions. It was also found that the pain index and the rate of chill/fever in the PPGD group were higher than in the PHGD group during and 12 h after puncture. Third, as described by Tsai and Hsieh<sup>[26]</sup>, the catheter of the PHGD group can be well fixed in the liver bed and serve as an anchor. It facilitates the dissection of Calot's triangle and achieves satisfactory hemostasis, thus accelerating the operation time and reducing the number of trocars.

One limitation of the present study was that it was a retrospective chart review rather than a randomized prospective study. In the process of postoperative evaluation of PC, only objective criteria such as pain index and the incidence of fever were used to indirectly reflect the possible situation of bile exudation around the gallbladder. If routine computed tomography were used to confirm the amount of fluid around the gallbladder, the reliability of this study would be improved. Also, only the Seldinger technique was used. If the trocar technology is used in PC, its effect on LC in a later period is unknown. In order to reach more accurate conclusions, prospective randomized studies should be carried out. This study had a small number of patients, and further, larger studies should be performed to corroborate these findings.

## CONCLUSION

In conclusion, in using Seldinger technology to complete PC, the method of abdominal puncture can lead to increased adhesion around the gallbladder, increased bleeding volume and extended operation time in subsequent LC. Therefore, in order to reduce the difficulty of LC in the later stage, we should try our best to choose PHGD in the early stage of AC.

## ARTICLE HIGHLIGHTS

### **Research background**

In elderly or critically ill patients with acute cholecystitis (AC), percutaneous cholecystostomy (PC) can be used as an immediate treatment, and cholecystectomy can be safely performed when the patient's condition improves. PC can serve as a bridge to cholecystectomy until the inflammatory process has subsided.

### **Research motivation**

There are two access routes for PC: The percutaneous transhepatic gallbladder drainage (PHGD) and the percutaneous transperitoneal gallbladder drainage (PPGD). Each approach has distinct advantages. However, few studies have reported the effects of the two different approaches on laparoscopic cholecystectomy (LC) followed by PC.

### **Research objectives**

This retrospective cohort study was undertaken to compare surgical results after LC followed by PHGD and PPGD to determine the optimal approach for LC after PC in patients with AC.

### **Research methods**

We retrospectively studied 103 patients with acute calculous cholecystitis who underwent scheduled LC after PC between January 2010 and January 2019. Group I included 58 patients who underwent scheduled LC after PHGD. Group II included 45 patients who underwent scheduled LC after PPGD. Clinical outcomes were analyzed according to each group.

### Research results

This study showed that there was no significant difference in the conversion rate to laparotomy, rate of subtotal cholecystectomy and rate of complications between the PHGD group and the PPGD group. However, the PHGD group required less operation time and resulted in lower intraoperative blood loss and shorter hospital stay.

### Research conclusions

Our results suggest that B-mode ultrasound-guided PHGD is superior to PPGD followed by LC for the treatment of AC. In order to reduce the difficulty of laparoscopic cholecystectomy after PC, we suggest choosing PHGD in the early stage of AC for elderly or critically ill patients.

### Research perspectives

In order to reach a more accurate conclusion, prospective randomized controlled trials should be carried out in the future.

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