Original Paper

Clinical Evaluation of Continuous Renal Replacement Therapy in Combination with Ultrasound-Guided Percutaneous Transhepatic Gallbladder Drainage for Acute Severe Biliary Pancreatitis: a Retrospective Study

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Key Words

Acute severe biliary pancreatitis • Continuous renal replacement therapy • Percutaneous transhepatic gallbladder drainage • Outcome • Complication

Abstract

Background/Aims: This study aimed to report the clinical efficacy of continuous renal replacement therapy (CRRT) in combination with ultrasound-guided percutaneous transhepatic gallbladder drainage (PTGD) (CRRT+PTGD) in the treatment of acute severe biliary pancreatitis (ASBP). **Methods:** Between January 2010 and January 2016, 40 cases of patients with ASBP who received routine CRRT (CRRT group) and 40 of those who received CRRT+PTGD (CRRT+PTGD group) at the Affiliated Hospital of Qingdao University (Qingdao, China) were retrospectively reviewed. Clinical (including abdominal pain remission time, gastrointestinal decompression time, Intensive Care Unit (ICU) hospital stay, respirator treatment time, and mortality rate), laboratory (white blood cells [WBC], platelet [PLT], procalcitonin [PCT], C-reactive protein [CRP], total bilirubin [TBIL], alanine aminotransferase [ALT], albumin [ALB], and blood lactic acid [Lac]) parameters, various critical disease scores, and incidence of complications after the treatment were compared between the two groups. **Results:** Compared with those in the routine CRRT group, patients in the CRRT+PTGD group exhibited significant remission of clinical symptoms (i.e. shorter abdominal pain remission time, gastrointestinal decompression time, respirator treatment time and ICU hospital stay) (all $P < 0.05$), change of laboratory parameters (WBC, PLT, PCT, CRP, TBIL, ALT) ($P < 0.05$), and improvement of various critical disease scores ($P < 0.05$).

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Moreover, the variation of most of the above parameters after versus before the treatment was greater in the CRRT+PTGD group than in the CRRT group (all $P < 0.05$). **Conclusion:** CRRT in combination with PTGD is more effective in the treatment of ASBP than CRRT alone.

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Published by S. Karger AG, Basel

Introduction

Severe acute pancreatitis (SAP) is an abdominal devastating disease that is characterized by persistent organ failure for over 48 h, prone to cause complicated systemic inflammatory response syndrome (SIRS), multiple organ dysfunction syndrome (MODS), and a high mortality rate [1-3]. In the early stage of SAP, the release of a large amount of inflammatory mediators may lead to systemic inflammatory response syndrome (SIRS), inflammatory cell infiltration, etc. in vital organs (such as lung, liver and kidney), which causes tissue edema, aggravates organ damage, and further results in MODS [4-7].

As a consequence of dietary structural changes, the incidence of biliary pancreatitis has been increasing. In China, biliary pancreatitis accounts for 60-70% of all cases of acute pancreatitis. At present, the treatment for severe acute biliary pancreatitis (SABP) is still challenging. Although the treatment methods for SAP have been greatly advanced, the mortality rate is still as high as up to 50% [8-10]. In recent years, endoscopic nasobiliary drainage, and endoscopic retrograde cholangiopancreatography (ERCP) in combination with pancreatic duct sphincterotomy have been using for patients with SABP, while often causing serious complications such as shock, acute respiratory distress syndrome (ARDS), and renal dysfunction [11, 12]. This often makes patients unable to tolerate surgery and may also increase the risks of anesthesia and postoperative complications. Therefore, it is vital to develop a minimally invasive bedside approach that can remove biliary obstruction and achieve complete bile drainage to decompress the biliary ducts.

CRRT has been widely used to treat acute renal failure, sepsis, MODS, and other critical diseases, with satisfactory efficacy [13-16]. CRRT can clear inflammatory mediators such as TNF- α , IL-6, and IL-8, and myocardial depressant factors in SAP, thereby blocking the chain reaction of SIRS and correcting sepsis and inflammatory responses [16-19]. It has also been shown that CRRT improves microcirculation and oxygen uptake of parenchymal cells by removal of interstitial edema, thereby improving oxygen utilization by tissues, adjusting water, electrolyte and acid-base balance, and stabilizing the internal environment [20]. In addition, CRRT can reduce the heavy load of liquid and facilitate nutritional support with the help of ultrafiltration, and can also alleviate immune dysfunction and multiorgan dysfunction, significantly reducing the mortality rate through the adsorption of endotoxin [20].

PTGD is a minimally invasive method that can drain bile and relieve pressure in pancreatic and biliary ducts to treat pancreatitis [21]. On the basis of removing inflammatory mediators and protecting vital organs through CRRT, ultrasound-guided PTGD may decompress the biliary ducts, alleviate clinical symptoms, and improve clinical indicators and severity scores for critical illness. Until now, there have been few studies evaluating the efficacy of PTGD or CRRT in combination with ultrasound-guided PTGD (CRRT + PTGD) in the treatment of ASBP. We herein reported our experience of employing CRRT + PTGD to treat ASBP at the Affiliated Hospital of Qingdao University, Qingdao, China.

Materials and Methods

Patients

Between January 2010 and January 2016, 200 cases of patients with ASBP were primarily retrospectively reviewed at the Intensive Care Unit (ICU), Affiliated Hospital of Qingdao University. ASBP was diagnosed in accordance with the ASBP diagnosis guideline (2007) of Chinese Medical Association [22]. Briefly, patients were diagnosed if they: 1) exhibited symptoms of acute abdominal pain with nausea

and emesis, jaundice, right upper abdomen tenderness and rebound tenderness; 2) had elevated levels of blood amylase and/or urine amylase; 3) had obvious elevation of the serum levels of total bilirubin (TBIL) and alanine aminotransferase (ALT); and 4) showed pancreas swelling, unevenly mass, extrapancreatic infiltration, swelling of gallbladder, effusion, thickening of gallbladder wall, common bile duct stones, roundworm and biliary dilatation revealed by ultrasound B or computed tomographic (CT) examination. Patients aged >18 years and those with complete medical information were included. Patients: 1) aged < 18 years, 2) with abnormal coagulation function, 3) needed emergent surgery to have cholecystectomy, 4) with biliary structural changes resulting from previous biliary duct surgery, and primary hepatic disease, or 5) with local infection in the puncture points, were excluded. Eventually, 40 cases of eligible patients who received routine CRRT and 40 cases of patients who received CRRT+PTGD were randomly selected from the clinical data and reviewed. This study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University (Qingdao, China). Written informed consent was obtained from each patient.

Treatment

Patients in both the two groups were fasted, and received oxygen administration, gastrointestinal decompression, nutritional support and appropriate analgesic-antispasmodic therapy. Water, electrolyte and acid-base imbalances were closely monitored and corrected, and the secretion of gastric acid and pancreatic enzymes were inhibited. Patients received enough antibiotics to prevent infection at an early stage, and complications were actively treated. Shock was treated by anti-shock method, heart failure with cardiotonic therapy, and ARDS with mechanical ventilation. Patients in the CRRT group received treatment on the day of admission and diagnosis, and those in the CRRT+ PTGD group were treated with ultrasound-guided bedside PTGD on the basis of CRRT, which was completed within 24 hours after admission.

CRRT therapy

Continuous veno-venous hemofiltration (CVVH) was carried out using a Baxter Accura hemofiltration system (Baxter, USA). By means of the Seldinger technique, the femoral or right internal jugular vein was punctured to place a single-needle catheter with double-lumen for temporary vascular access. The used dialyzer (HF1200, Baxter), with a surface area of 1.8-2.1 m², was changed every 4 to 12 h using the predilution mode, and the hemofiltration was provided continuously for 24 h. The blood flow rate was 200-300 ml/min. 3000 ml 0.9% saline (Baxter) was used as the replacement solution, and the electrolyte composition was adjusted and the acid-base imbalance was corrected according to the specific conditions of patients. The amount of ultrafiltration was determined according to the daily volume of fluid replacement and physiological requirement. Continuous infusion of standard heparin was used for anticoagulation and that of regular insulin was to control blood glucose, and the infused amount was adjusted according to APTT and blood glucose levels. In patients with a bleeding tendency, heparin was stopped. CRRT treatment was terminated if a single physiological index of APACHE II scoring system <6 points, heart rate <90 beats/min, and respiratory rate <20/min were observed in patients.

Minimally invasive PTGD approach

Patients received ultrasonography before PTGD using a portable Doppler ultrasound machine (Vivid i, GE, USA) to determine the size and position of the gallbladder and condition of surrounding organs. In brief, patient were maintained in a supine position, and the puncture point was positioned in the intercostal space between the 8th and 9th ribs along the right anterior or middle axillary line. The skin was routinely disinfected, towels were placed around the puncture site, 2% lidocaine was used for local anesthesia, and an color Doppler flow imaging (CDFI) was then carried out to detect blood flow and guide the needle to avoid larger blood vessels in the liver and kidneys. The needle was guided by ultrasound through the skin and liver to puncture the gallbladder from its bed. After the bile flow was attempted aspirating, a guidewire was implanted, and the needle was retracted. When the skin was stretched, a drainage catheter was inserted along the guidewire which was then retracted; the gallbladder drainage catheter was fixed and connected to an external drainage bag. The bile was collected to send out for bacterial culture. To facilitate drainage, the drainage catheter was washed with normal saline every day. For patients with gallbladder stones, the indicators for removing the drainage catheter were: 1) drainage for more than 7 days; 2) no abdominal pain, fever, or jaundice; 3) clear and transparent bile, yellow or yellow-green, with no pus or clumps; 4) negative

bacterial culture for biliary. The catheter was tried to be clamped for one day, and then could be removed if no discomfort was found in patients. For calculous cholecystitis patients, when symptoms of gallbladder inflammation were completely resolved and the size and morphology of the gallbladder returned to normal revealed by ultrasonography, the catheter was clamped for 2 days after a sinus was formed. If patients showed no discomfort, the drainage catheter could be removed. All operations were performed by one same physician with many years of experience of bedside biliary ultrasound diagnosis and puncture.

Definition of treatment-related indicators

Pain: pain was evaluated by visual analog scale (VAS). Alleviation of abdominal pain was defined as a 3-point reduction of VAS.

Gastrointestinal decompression: A gastrointestinal decompression tube was routinely placed for decompression in all patients diagnosed with SAP. Daily drainage of less than 200 ml indicated almost recovery of gastrointestinal function, when the gastrointestinal decompression tube could be removed.

Duration of mechanical ventilation: Ventilation could be stopped when the heart rate was <120 beats/min, spontaneous breathing rate was 8-30 times/min, tidal volume >4 ml/kg, and blood gas analysis showed an oxygenation index ≥ 150 mmHg. The duration of mechanical ventilation was defined as the time from start to termination of ventilation.

Length of ICU stay was defined as the period of hospital stay in the ICU. Patients who died in the ICU were not included.

Scoring system: Acute Physiology and Chronic Health Evaluation-II (APACHE-II) is used to evaluate acute physiological and chronic health scoring. The total score ranges from 0 to 7 points, with a higher score indicating a more severe physical condition.

Balthazar CT score reflects the extent of pancreatic lesions, ranging from 0 to 6 points, and a higher score indicates a more severe condition.

MODS score indicates dysfunction occurred sequentially in two or more organs or systems in critical diseases such as shock, trauma, severe infection, burns and severe pancreatitis. MODS score comprises score of 6 visceral organ systems, with each organ score ranging from 0 to 4 points; the total MODS score ranges from 0 to 24, with a higher score reflecting a more severe condition [1]

Measurement

Body temperature, heart rate, respiration, blood pressure, pulse oxygen, abdominal pain remission time, gastrointestinal decompression time, respirator treatment time, ICU hospital stay, and mortality rate of patients were recorded. Incidence of complications (including ARDS, acute renal failure [ARF], MODS, abdominal infection, bile leakage, abdominal bleeding, intestinal injury, catheter displacement and slipping) were also recorded.

In addition, clinical outcomes (including abdominal pain time, gastrointestinal decompression time, ICU hospital stay, respirator treatment time, and mortality rate), blood routine parameters (including white blood cells [WBC], platelet [PLT], procalcitonin [PCT], and C-reactive protein [CRP]), hepatic and kidney function parameters (including total bilirubin [TBIL], aminotransferase [ALT], and albumin [ALB], blood-gas parameter (blood lactic acid [Lac], and critical disease scores (i.e. APACHE II, Balthazar CT, and MODS scores) were measured upon the admission and at one week after the treatment.

Table 1. Clinical symptoms between the CRRT and CRRT+PTGR groups. CRRT, continuous renal replacement therapy; PTGD, percutaneous transhepatic gallbladder drainage; ICU, intensive care unit. * $P < 0.05$ compared with CRRT group

Group	Abdominal pain time (d)	Gastrointestinal decompression time (d)	ICU hospital stay (d)	Respirator treatment time (d)	Mortality rate (n/%)
CRRT group (n=40)	4.7 $\pm$ 0.5	10.8 $\pm$ 1.5	21.8 $\pm$ 2.4	9.6 $\pm$ 1.3	5 (12.5)
CRRT+PTGD group (n=40)	2.0 $\pm$ 0.4*	5.2 $\pm$ 0.9*	14.2 $\pm$ 1.1*	5.8 $\pm$ 1.1*	3 (7.5)
P value	0.027	0.014	0.029	0.003	0.710

Statistics

The data were analyzed using SPSS 13.0 software (SPSS Inc. Chicago, IL, USA). Quantitative data were expressed as mean±standard deviation and were compared between groups using t-test. Enumeration data was compared using χ^2 test. $P<0.05$ represented statistical difference.

Results

Basic characteristics

There were 80 patients with ASBP in this study, including 46 males and 34 females, with a mean age of 45.5 ± 9.2 (range 21-81) years. Sixty-five (81.25%) cases of ASBP were from cholelithiasis, 1 (1.25%) from roundworm, and 14 (17.5%) from Oddi sphincter stenosis. There were 40 cases of patients who received routine CRRT and 40 cases of patients who received CRRT+PTGD. There were no significant difference in gender, age and complications between the two groups ($P>0.05$).

Comparison of blood biochemical parameters before and after the treatment between the two groups

Table 1 showed abdominal pain time, gastrointestinal decompression time, ICU hospital stay, and respirator treatment time were significantly less in the CRRT+PTGD group than in the CRRT group (all $P<0.05$). In addition, mortality rate was insignificantly less in the CRRT+PTGD group ($P=0.710$).

Before the treatment, there was no significant difference in the blood routine parameters (WBC, PLT, PCT, CRP), hepatic function parameters (TBIL, ALT, ALB) and blood-gas parameter (Lac) between the two groups ($P>0.05$). At one week after the treatment, WBC, PCT, CRP, TBIL, and Lac were significantly decreased (all $P<0.05$) while PLT was significantly increased ($P=0.012$) in the CRRT+PTGD group when compared with the CRRT group. In both the two groups, these biochemical parameters were significantly changed after one-week treatment in comparison with those before the treatment; Moreover, the variation of WBC, PLT, TBIL, and Lac after versus before the treatment was significantly greater in

Table 2. Variation before and after the treatment between the CRRT and CRRT+PTGR groups. CRRT, Continuous renal replacement therapy; PTGD, percutaneous transhepatic gallbladder drainage; ICU, intensive care unit. WBC, white blood cells; PLT, platelet; PCT, procalcitonin; CRP, C-reactive protein; TBIL, total bilirubin; ALT, alanine aminotransferase; ALB, albumin; Lac, blood lactic acid. ^a $P<0.05$ compared with CRRT group at one week after the treatment, ^b $P<0.05$ compared with parameters before the treatment

Variable	CRRT group (n=40)	CRRT+PTGD group (n=40)	P value
WBC ($\times 10^9/L$)			
Before the treatment	22.15±5.74	22.11±5.69	0.979
At 1 week after treatment	13.62±4.33 ^b	9.40±4.38 ^{ab}	<0.001
Variation	-8.54±4.99	-12.72±6.07	0.001
PLT ($\times 10^9/L$)			
Before the treatment	49.51±20.99	49.2±20.7	0.949
At 1 week after treatment	90.75±29.84 ^b	128.35±85.95 ^{ab}	0.012
Variation	41.25±18.40	79.15±75.23	0.03
PCT (ng/ml)			
Before the treatment	16.95±11.33	16.80±11.65	0.953
At 1 week after treatment	2.59±2.57 ^b	1.60±1.56 ^{ab}	0.04
Variation	-14.35±10.48	-15.20±11.28	0.731
CRP (mg/L)			
Before the treatment	75.75±25.51	75.78±24.59	0.996
At 1 week after treatment	13.78±6.44 ^b	8.25±5.01 ^{ab}	<0.001
Variation	-61.96±24.96	-67.53±23.83	0.312
TBIL ($\mu\text{mol/L}$)			
Before the treatment	56.00±18.20	55.83±16.90	0.965
At 1 week after treatment	37.50±13.49 ^b	26.27±11.14 ^{ab}	<0.001
Variation	-18.50±16.82	-29.55±15.47	0.003
ALT (U/L)			
Before the treatment	204.03±210.46	204.33±201.99	0.995
At 1 week after treatment	80.80±67.39 ^b	65.03±53.18 ^b	0.249
Variation	-123.23±165.50	-139.30±156.37	0.656
ALB (g/L)			
Before the treatment	22.71±8.24	22.73±7.3	0.993
At 1 week after treatment	35.00±7.84 ^b	36.29±8.29 ^b	0.479
Variation	12.28±6.88	13.55±7.49	0.432
Lac (mmol/L)			
Before the treatment	4.40±2.11	4.30±2.11	0.854
At 1 week after treatment	1.76±1.65 ^b	1.01±0.56 ^{ab}	0.009
Variation	-2.64±0.89	-3.29±1.76	0.039

the CRRT+PTGD group than the CRRT group (all $P<0.05$) (Table 2).

Comparison of clinical symptoms before and after the treatment between the two groups

Before the treatment, there were no significant difference in the APACHE II, Balthazar CT and MODS scores between the CRRT and CRRT+PTGD groups (all $P>0.05$). After one-week treatment, these scores in both the two groups were significantly decreased compared with those before the treatment (all $P<0.05$). Moreover, these scores were significantly decreased in the CRRT+PTGD group in comparison with CRRT group (all $P<0.05$), and the decrease of these scores after versus before the treatment was also significantly greater in the CRRT+PTGD group (all $P<0.05$) (Table 3).

Combinations between the two groups

Compared with the CRRT group, the incidence of complications including ARDS, ARF and MODS was significantly lower in the CRRT+PTGD group ($P<0.05$, Table 4). In the CRRT+PTGD group, there were 2 cases of biliary leakage which was recovered after the peritoneal drainage,

Table 3. Comparison of clinical symptoms between the CRRT and CRRT+PTGR groups. CRRT, continuous renal replacement therapy; PTGD, percutaneous transhepatic gallbladder drainage; MODS, multiple organ dysfunction syndrome. ^a $P<0.05$ compared with CRRT group at one week after the treatment, ^b $P<0.05$ compared with those before the treatment

Variable	CRRT group (n=40)	CRRT+PTGD group (n=40)	P value
APACHE II scores			
Before the treatment	25.18±7.21	25.38±6.26 ^a	0.895
After the treatment	15.00±7.09 ^b	11.10±7.10 ^{a b}	0.016
Variation	-10.18±5.47	-14.28±6.16	0.002
Balthazar CT scores			
Before the treatment	6.82±1.43	6.67±1.27 ^a	0.621
One week after the treatment	5.15±1.61 ^b	4.00±1.24 ^{a b}	0.001
Variation	-1.68±1.29	-2.68±1.59	0.003
MODS score			
Before the treatment	15.41±2.97	15.40±2.86 ^a	1
After the treatment	12.45±3.6 ^b	9.20±2.8 ^{a b}	<0.001
Variation	-2.95±2.40	-6.2±2.90	<0.001

Table 4. Combinations in the two groups. CRRT, continuous renal replacement therapy; PTGD, percutaneous transhepatic gallbladder drainage; SIRS, systemic inflammatory response syndrome; MODS, multiple organ dysfunction syndrome. ^a $P<0.05$ compared with CRRT group

	ARDS (n/%)	ARF (n/%)	MODS (n/%)	Abdominal infection (n/%)
CRRT group (n=40)	27(67.5)	16(40)	3(7.5)	2(5)
CRRT+PTGD group (n=40)	17(42.5) ^a	8(20) ^a	2(5) ^a	2(5)

1 case of catheter slipping which was treated by resetting of the gallbladder drainage. No abdominal bleeding, intestinal damage or other complications were observed.

Discussion

CRRT has been commonly employed to treat acute renal failure, sepsis, MODS, and other critical diseases, which achieved satisfactory efficacy [13-16]. In this study, we showed that one-week CRRT treatment significantly improved laboratory indices (WBC, PLT, PCT, CRP, TBIL, ALT, ALB, Lac) and clinical symptoms (APACHE II, Balthazar CT and MODS scores) in patients with SABP in the both groups, indicating that early use of CVVH-involved CRRT for SABP patients is safe and effective.

Biliary pancreatitis is mainly due to duodenal papillary obstruction caused by biliary stones, cholangitis, or cholecystitis, which results in a blockage of pancreatic fluid flow and subsequent trypsin activation that causes autodigestion, leading to acute pancreatitis [23-25]. Therefore, in the treatment of ASBP it is essential to remove biliary obstruction and relieve of pressure in the pancreatic and biliary ducts. With the development of minimally invasive surgery, ERCP in combination with papillary sphincterotomy or transnasal biliary drainage has been playing an important role in removing the obstruction to treat ASBP [12], but some portion of patients cannot tolerate this treatment due to their critical condition. Thus, a minimally invasive method that can achieve biliary drainage and bile duct decompression is particularly important for these patients [25-27]. It was shown that the duration of increased pressure in the pancreatic duct caused by common bile duct obstruction in the ampulla is closely associated with the severity of pancreatic lesions [28]. Further studies indicated that the duration of obstruction in the ampulla is correlated with the severity of gallstone pancreatitis [29-32]. The most common lesions in the pancreas at 24-48 h are bleeding and fat necrosis; and after 48 h, extensive bleeding and necrosis can occur in the pancreas. Therefore, the most critical step for the treatment of ASBP is to remove obstruction in the bile and pancreatic ducts as soon as possible (within 24 h), which ensures the unobstructed drainage of pancreatic fluid and bile.

PTGD is a minimally invasive method that can drain bile and relieve pressure in pancreatic and biliary ducts to treat pancreatitis. Lee et al. recommended endoscopic sphincterotomy (EST) for ASBP at the early stage, but EST is technically challenging with high risks [33]. Moreover, the coagulation current itself used in EST would damage the pancreas and may aggravate pancreatitis. The efficacy of PTGD is similar to that of EST; it is minimally invasive, easily operated that can be carried out at the bedside, and costs low. Therefore, we believe that using ultrasound-guided PTGD at the early stage to treat ASBP specifically targets key pathogenic factors, and it is a safe and effective method that is especially suitable for critically ill patients on mechanical ventilation who are receiving CRRT and should not be moved. In this study, we showed that in comparison with the CRRT group, patients in the CRRT + PTGD group exhibited significantly better clinical outcomes (abdominal pain time, gastrointestinal decompression time, ICU hospital stay, and respirator treatment time), greater improvement in some laboratory indices (WBC, PLT, TBIL, and Lac) and clinical symptoms (APACHE II, Balthazar CT and MODS scores) as well as less incidence of complications. In addition, the mortality rate was also reduced, although not significantly. This result indicates the important role of PTGD in relieving obstruction and protecting the function of the pancreas and other organs, and also demonstrated greater treatment efficacy achieved by CRRT + PTGD treatment.

Any invasive procedure has certain risks and complications. Among the 40 patients in the CRRT + PTGD group, bile leakage occurred in 2 patients after surgery, probably due to improper positioning of the catheter and partial lateral hole in the liver parenchyma or outside of the liver. The patients' condition was alleviated after the depth of the catheter was adjusted and abdominal drainage was actively performed. In addition, proper fixation

of the catheter is particularly important. In one patient in this group, the catheter slipped off, causing inadequate drainage, which was due to improper fixation and displacement caused by external stress. The patient's symptom was relieved after the replacement of the catheter. From experience, we believe that accurate positioning with ultrasound is critical for puncture during PTGD. The needle should be inserted inward from the lower edge of the liver at the intersection between the upper and middle 1/3 sites of the gallbladder bed. The gallbladder bed is located at the junction of liver segments IV and V, far from the hepatic pedicle. Therefore, except terminal branches of the middle hepatic vein, no obvious great blood vessels are present at this location. Meanwhile, the puncture and catheter placement from the lower edge of the liver allow proper fixation of the catheter, which prevents slip-off of the catheter from the gallbladder and bile leakage due to the lack of support. Therefore, during the ultrasound-guided PTGD, accurate ultrasound positioning, solid anatomical knowledge, and reliable catheter fixation and care are the basis for the successful puncture and catheter placement.

There are some limitations in this study. This is a retrospective study in nature that might bring about bias of patient selection and also incompleteness of some important patients' clinical information. In addition, the sample size of this study is also limited. Next, a prospectively designed study with more patients will be needed to validate the present result.

Conclusion

CRRT in combination with ultrasound-guided PTGD is more effective for the treatment of ASBP in comparison with CRRT alone. CRRT with PTGD method for ASBP is minimal invasive and convenient for bedside operation, with good efficacy in bile duct decompression.

Acknowledgements

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Disclosure Statement

The authors declare they have no Disclosure Statement.

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