Early ultrasound-guided percutaneous catheter drainage in the treatment of severe acute pancreatitis with acute fluid accumulation

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Abstract. The clinical effect of early percutaneous ultrasound guided percutaneous catheter drainage (PCD) in treating severe acute pancreatitis complicated with acute fluid accumulation in the abdominal cavity was analyzed. A total of 178 patients with severe acute pancreatitis complicated with acute fluid accumulation in peritoneal cavity admitted from January, 2011 to January, 2015 to Chuiyangliu Hospital were retrospectively analyzed. Based on the treatment, patients were divided into the following groups: PCD group and conservative treatment control group. Time-period of systemic inflammatory response (SIRS), time-period of abdominal pain, bowel sounds recovery time, dietary recovery time, hospitalization days, white blood cell count, serum amylase, C-reactive protein, serum calcium and complications in both groups were observed and compared. The measurement data between the two groups were presented as mean ± standard deviation (±SD), and analyzed by t-test. Classification data were analyzed by the Chi-square test, with $P<0.05$ indicating a statistically significant difference. Time-period of systemic inflammatory response (SIRS), time-period of abdominal pain, bowel sounds recovery time, dietary recovery time and hospitalization days were shorter in the PCD group than those in the control group ($P=0.001$). Improvements of white blood cell count, serum amylase, C-reactive protein and serum calcium were better than those of the control group ($P<0.001$), the rate of transferring to surgical department in the PCD group was lower than that of the control group ($P=0.042$), and complications of severe acute pancreatitis were not significantly different in the two groups ($P>0.05$). In this study, 6 adverse events occurred in the PCD group, accounting for 7.9% (6/76), including 1 case of puncture bleeding and 5 cases of obstruction. In conclusion, early ultrasound-guided PCD in treating severe acute pancreatitis is effective and safe.

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Introduction

Acute pancreatitis is a commonly seen gastrointestinal disorder and its incidence is on the increase worldwide. As a rapidly progressive disease severe acute pancreatitis (SAP) has a high mortality rate accompanied with a high incidence of complications, which are life-threatening. Bai *et al* (1) reported that the overall mortality rate of SAP in China and in western countries was 11.8 and 10-40%, respectively (2). Ultrasound-guided percutaneous drainage (PCD) has become an important means of treatment of severe pancreatitis, and a large number of inflammatory mediators, enzymes, and toxic metabolites can be drained *in vitro*, thus reducing the stimulation of retroperitoneal plexus and pancreatic edema, improving pancreatic microcirculation, thereby promoting intestinal function recovery (3). The most severe acute pancreatitis in a short organ failure or with acute abdominal cavity effusion most likely is repaired by absorption (4). Some scholars believe that the early treatment of aseptic fluid accumulation may lead to exogenous infection and aggravate pancreatitis (5). Early PCD combined with early antibiotic use can reduce the release of inflammatory mediators and the recovery of infection (6).

There is disagreement on the efficacy and safety of early PCD in treating severe acute pancreatitis. This study aimed to compare the efficacy of early PCD in patients with severe acute pancreatitis combined with acute pancreatic fluid accumulation using a retrospective approach.

Patients and methods

Patients. A total of 178 patients diagnosed as acute and severe acute pancreatitis complicated with acute fluid accumulation in peritoneal cavity admitted from January 2011 to January 2015 to Chuiyangliu Hospital (Beijing, China) were retrospectively analyzed. This study was approved by the Ethics Committee of Chuiyangliu Hospital Affiliated to Tsinghua University. Informed consent was obtained from all the participants prior to the study. Based on the treatment, the

patients were divided into the following groups: PCD group and conservative treatment control group. There were 76 cases in the PCD group, of whom 32 were male and 44 were female, and 102 cases in the conservative treatment control group, of whom 48 were male and 54 were female. Inclusion criteria were: i) age range, 18-75 years; ii) in line with the diagnosis of severe acute pancreatitis in 'diagnosis and treatment of acute pancreatitis guide' (7); and iii) SIRS still existed 24 h after admission for fluid infusion. Exclusion criteria for the study were: i) combined with severe basal heart and lung disease; ii) combined with coagulation disorders; and iii) patients had to be treated early by surgery with abdominal hypertension caused by multiple organ dysfunction. PCD criteria for the drainage group were: i) occurrence of acute abdominal fluid accumulation with abdominal pressure (intraperitoneal pressure >15 mmHg); ii) ultrasound or CT examination showed a large number of intra-abdominal effusion depth >5 cm; and iii) fluid amount increased in the continuous reviews twice, and the fluid growth rate was >2 cm/24 h.

Methods. Patients in the control group underwent conservative treatment, were given regular fasting, sustained gastrointestinal decompression, liquid resuscitation, maintance of water and electrolyte balance, intravenous injection of trypsin inhibitors, proton pump inhibitors and antibiotics. On the basis of conservative treatment, patients in the drainage group underwent PCD treatment on the second day after admission. According to the ultrasound localization and percutaneous puncture with the aid of ultrasound after local anesthesia, after the effusion was withdrawn, the guide wire was implanted with PTCD catheter along the guide wire, making sure that catheter implantation was well placed under ultrasound, the guide wire was pulled out, and the extracts were sent for routine examination, lipase and bacterial culture examination. Infections were defined as positive bacterial cultures of peritoneal drainage or abdominal CT suggestive of an abdominal infection. Extubation standard was: i) Drainage per day <10 ml, imaging examination results showed disappearance of liquid dark area; and ii) intraperitoneal infection was excluded according to the drainage fluid before extubation fluid. Bowel sounds recovery time, time-period of SIRS, dietary recovery time, defecation ventilation time, time-period of abdominal pain, hospitalization days, and laboratory indicators (white blood cell count, blood amylase, blood lipase, C-reactive protein and serum calcium) were assessed. In the follow-up for 2 years, complications of severe acute pancreatitis were observed.

Statistical analysis. SPSS 12.0 software (BM Corp., Armonk, NY, USA) was used for statistical analysis. The measurement data between the two groups were expressed as mean ± standard deviation (±SD). The Student's t-test was used and categorical data were analyzed by the Chi-square test. P<0.05 indicated a significant difference.

Results

General results. The present study enrolled 178 patients diagnosed as severe acute pancreatitis complicated with acute pancreatic fluid accumulation during the period 2011-2015 in the Department of Gastroenterology. The PCD drainage group comprised 76 patients, of whom 32 were male and 44 were female, with a mean age of 44.0±3.4 years. A total of 102 patients were in the control group, of whom 41 were male and 61 were female, with a mean age of 45.5±3.3 years. General information of patients in the two groups were comparable (P>0.05) as shown in Table I.

Table I. Patient characteristics.

Characteristics	PCD	Control
Patient, no.	76	102
Mean ± standard deviation age (years)	44.0±3.4	45.5±3.3
Sex, male/female	32/44	41/61
Cause of acute pancreatitis		
Bile duct diseases	53	68
Alcohol	15	25
Hyperlipidemia	8	7
Infection	0	2

PCD, percutaneous catheter drainage.

Clinical efficacy results. The time-period of SIRS, time-period of abdominal pain, bowel sounds recovery time, dietary recovery time, and hospitalization days were shorter in the PCD group than those in the control group (P=0.001) (Table II and Fig. 1).

Laboratory indicators. Improvements of white blood cell count (WBC count), serum amylase, C-reactive protein (CRP), and serum calcium were better than those of the control group (P<0.001) (Fig. 2).

Clinical outcomes. There were 76 patients in the PCD group and 73 were successfully treated. Three patients who underwent external drainage or surgical treatment were transferred to surgical departments. One patient succumbed to multiple organ failure. Of the total 102 patients in the control group, 89 patients underwent conservative treatment of the disease and were significantly improved, 13 were surgically treated, and 3 succumbed to multiple organ failure. The surgical rates in the PCD and control groups were 7.9 and 12.8%, respectively (P=0.042). The mortality rate in the PCD and control groups was 1.3 and 2.9%, respectively (P>0.05). The cure rate of the PCD and control group was 98.6 and 97.1%, respectively (P>0.05) (data not shown).

Adverse events and complications. In this study, 1 case had bleeding in the PCD group, while in 5 cases drainage tube obstruction occurred, and the 5 cases achieved recanalization through the guide wire. No drainage tube slippage and intra-abdominal infection occurred. Pancreatitis complications in this study included pancreatic pseudocyst, pancreatic abscess and multiple organ failure. Among them, there were 5 cases of pancreatic abscess in the PCD group, 1 of multiple organ failure that was transferred for surgical treatment, and 8 of pancreatic pseudocysts. However, in the control group, there were 8 cases of pancreatic abscess, 5 of multiple organ failure

Table II. Results of clinical efficacy.

Variable	Time-period of SIRS (days)	Time-period of abdominal pain (days)	Bowel sounds recovery time (days)	Dietary recovery time (days)	Hospitalization time (days)
Treatment	3.16±0.71	5.89±1.25	8.37±1.56	11.59±0.93	17.41±3.24
Control	3.99±0.74	7.31±0.95	10.74±1.43	15.43±0.87	21.23±3.65
P-value	0.001	0.001	0.001	0.001	0.001

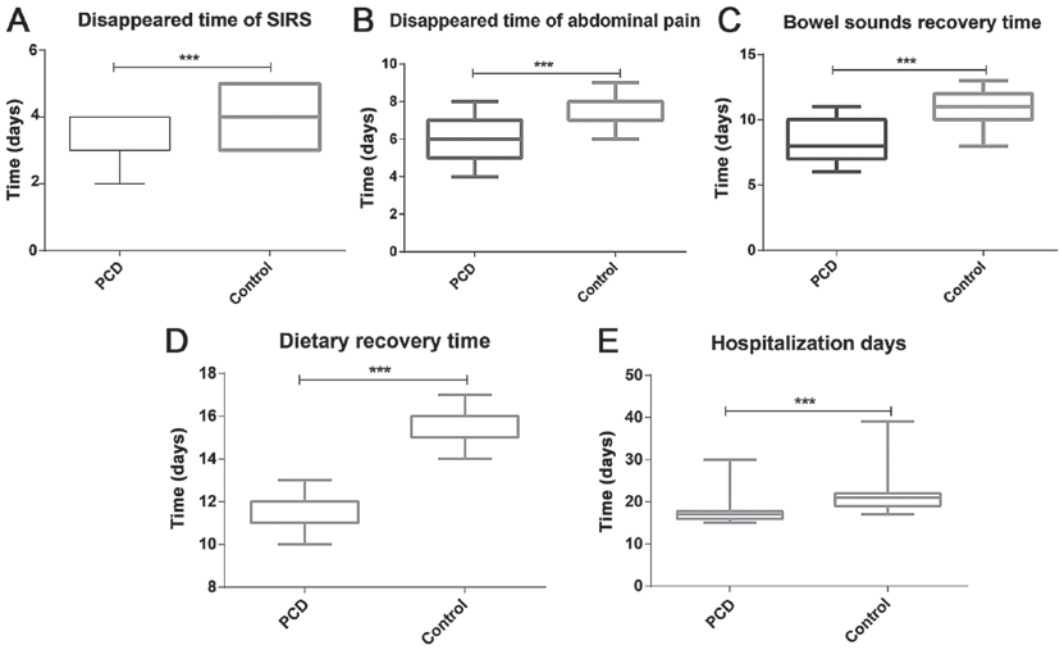

Figure 1. Clinical efficacy compared between two groups. (A) The time-period of SIRS, (B) relief of abdominal pain, (C) recovery time of bowel sounds, (D) dietary recovery time, and (E) hospitalization days are shorter in the PCD group compared to the control group. ***P<0.001.

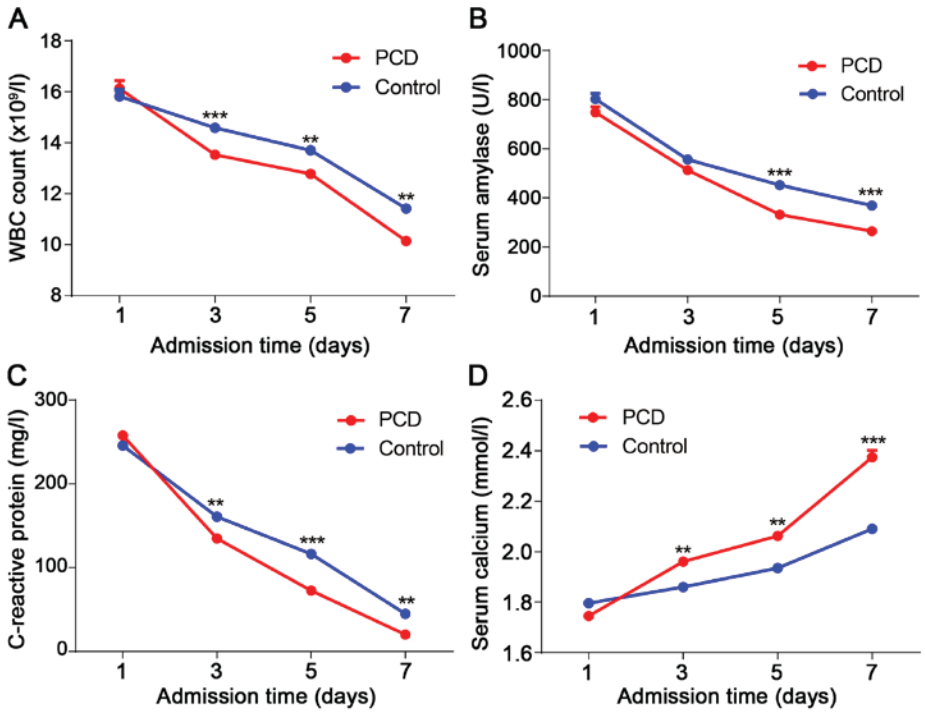

Figure 2. Comparison of laboratory indicators with time between two groups. (A) White blood cell count (WBC count), (B) serum amylase , and (C) C-reactive protein (CRP) decreased more quickly in the PCD group. (D) Serum calcium improved faster in the PCD group. **P<0.01 and ***P<0.001.

Table III. Outcome of adverse events and complications.

	Bleeding	Tube obstruction	Intra-abdominal infection	Pancreatic abscess	Pancreatic pseudocysts	Multiple organ failure
PCD	1	5	0	8	5	1
Control	0	0	0	12	8	5

and they were transferred for surgical treatment. Pancreatic pseudocysts occurred in 12 cases. No significant differences in adverse events and complications were found between the two groups (P>0.05). Early PCD treatment showed no effect of reducing the incidence of pancreatitis. No significant difference in the incidence of pancreatic pseudocysts was found between the two groups, indicating that early PCD did not increase the probability of pancreatic pseudocysts (Table III).

Discussion

As reported, percutaneous catheter drainage (PCD) was a minimally invasive intervention for severe acute pancreatitis (SAP) (8). Since PCD was first introduced by Freeny *et al* (9), it has been used as a definitive treatment in approximately one-third of patients with infected necrosis. The 2012 Atlanta Amendment proposed a viable PCD for acute necrotic deposits of more than 5 cm in patients diagnosed as severe acute pancreatitis. Therefore, it lays a theoretical basis for acute fluid accumulation in early PCD drainage, however, a large number of clinical studies are still lacking (10).

In theory, in the case of acute pancreatic fluid actively engaged in any kind of invasive procedure, the bacteria outside of the body could enter the third interval through the iatrogenic operation, which could increase the risk of retrograde infection. However, there are also the opposite hypotheses. Some studies have reported that drainage treatment of acute aseptic fluid accumulation does not increase the risk of infection complications of pancreatitis (11,12). In a study of 32 patients with severe pancreatitis, the average time for the recovery of CRP level in the operating group was 43.8 days compared with the PCD group (23.8 days), which was significantly increased (P=0.034). Therefore, it is considered that PCD is more conducive to the control of inflammatory response and infection (6). Studies on the early PCD drainage of acute pancreatic fluid accumulation to improve the clinical efficacy of acute pancreatitis are few, this retrospective study was carried out based on this need.

Time-period of systemic inflammatory response (SIRS), time-period of abdominal pain, bowel sounds recovery time, dietary recovery time and hospitalization days were shorter in the PCD group than those in the control group (P=0.001), suggested that early PCD can more significantly improve the condition of patients with severe acute pancreatitis than conservative treatment. In a comparison of laboratory indicators, white blood cell count, serum amylase, C-reactive protein and serum calcium in the PCD group were all better than those of the control group (P<0.001), which indicated that the early PCD treatment could improve the laboratory indicators and decrease inflammatory response. Therefore, early PCD treatment can improve the symptoms of patients, which has a certain effect on diagnosis and treatment of severe acute pancreatitis. The CRP level predicts the severity of acute pancreatitis (13). In a study of 30 SAP patients treated with PCD, 19 were completely cured. The PCD CRP levels were 172.8 and 102.5 mg/l after PCD (P<0.05). Therefore, PCD can reduce inflammation and reduce the risk of infection (14). In this study, the decrease of CRP in drainage group was significantly better than the control group, suggesting that PCD group achieved a better prognosis than the control group.

At present, there are still controversies on PCD treatment for these patients in clinic. Theoretically, any kind of invasive operation on acute pancreatic fluid accumulation may increase the risk of retrograde infection. In a control study of 40 patients, 4 (4/20) cases of infection were reported in the conservative group, 11 cases (11/20) infection in the peritoneal drainage group, and one death, so drainage group increased the risk of infection by 35% (15). However, some studies have reported that draining treatment of aseptic fluid accumulation in acute pancreatitis did not increase the risk of pancreatitis infection complications (11,12). In this study, the PCD group was first performed drainage after puncture and before extubation for bacteria culture, among them, 5 cases had pancreatic abscess, while there was no significant differences in the abscess incidence between the control group and PCD group, indicating that the early PCD did not increase the probability of intra-abdominal infection. In this study, 1 patient died in the PCD group and 3 in the control group; the difference was not statistically significant. Therefore, the early PCD treatment did not increase the mortality of severe acute pancreatitis.

In the present study, the cure rate and mortality in the PCD and control groups were similar, although the cure rate and mortality in the PCD group were better, statistical difference was lacking, suggesting that early PCD did not significantly improve the patient's final outcome of the disease (P>0.05). The rate of surgical transfer in the PCD group was significantly lower than that of the control group (P<0.05), suggesting that early PCD can ease further deterioration of the severity of acute pancreatitis and reduce the probability of surgery, which was an alternative medical treatment.

For adverse events and complications of pancreatitis, 1 case occurred bleeding in the PCD group and 5 had occlusion, they were all properly treated. In the complication of pancreatitis-related outcomes, there was no significant difference in the incidence of complications comparing the two groups. Early PCD treatment showed no effect of reducing the incidence of complications. Considering the small sample size, this study failed to reflect the effect.

In summary, early PCD treatment of patients with severe acute pancreatitis combined with acute pancreatic fluid accu-

mulation can effectively improve the symptoms and prevent further deterioration of the disease. However, early PCD would not increase the probability of intra-abdominal infection. Therefore, our results showed that the early PCD treatment of severe acute pancreatitis combined with acute pancreatic fluid accumulation was safe and effective. Some of the limitations of this study are noteworthy, first, it was a retrospective, single-center study; second, the sample size was limited. To further investigate the efficacy and safety of early acute pancreatitis in patients combined with acute pancreatitis, prospective studies containing large samples are required.

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Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Authors' contributions

HL and YW designed the study. CX and HA collected the patient data. CG and HC analyzed the patient data. All authors read and approved the final manuscript.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Chuiyangliu Hospital Affiliated to Tsinghua University (Beijing, China). Informed consent was obtained from all the participants prior to the study.

Patient consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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