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Original Article

Efficacy of ultrasound-guided percutaneous catheter drainage in treatment of severe acute pancreatitis complicated with necrosis and infection

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Abstract: *Background and aim:* Open surgery is a traditional method for treating severe acute pancreatitis (SAP), but it has greater trauma to the patient's body, so the incidence of postoperative complications is high. This study aimed to investigate the efficacy of ultrasound-guided percutaneous catheter drainage (PCD) in the treatment of SAP complicated with necrosis and infection. *Methods:* Eighty patients with SAP complicated with necrosis and infection were enrolled in this study. According to the treatment method, patients were divided into the control group (42 cases) and the observation group (38 cases), which received open abdominal drainage and ultrasound-guided PCD, respectively. Treatment efficacy, laboratory indicators, inflammatory indexes, drainage liquid bacteria culture, hospitalization time, reoperation and death/abandonment in two groups were measured and compared. *Results:* After treatment the blood WBC, blood amylase, urinary amylase, blood glucose levels, serum procalcitonin, C-reactive protein, tumor necrosis factor-α, and interleukin-6 levels in the observation group were significantly lower than those in the control group, respectively ($P < 0.05$), and the hospitalization time and death/abandonment rate in the observation group were significantly lower than those in the control group, respectively ($P < 0.05$). There was no significant difference between the effective rate of treatment or the bacterial culture result between the two groups ($P > 0.05$). *Conclusion:* Ultrasound-guided PCD is an effective and safe method for treatment of SAP complicated with necrosis and infection. It is worthy of clinical application.

Keywords: Percutaneous catheter drainage, severe acute pancreatitis, necrosis, infection, efficacy

Introduction

Severe acute pancreatitis (SAP) is a common clinical acute critical disease. Its main manifestations include abdominal pain, abdominal distention, fever, and nausea [1]. Late-stage SAP can induce severe complications such as pancreatic necrosis, tissue infection, sepsis and multiple organ dysfunction syndromes, which seriously influence the quality of life of patients [2]. SAP has acute onset, critical and complex condition and poor prognosis [3]. Research [4, 5] has shown that in more than 70% patients the SAP is related to excessive drinking, biliary tract diseases, and binge eating and drinking. The mortality rate of SAP is as high as 10%-30% [6]. Open surgery is a traditional method for treating SAP. Although open surgery can remove the lesion tissue, it has greater trauma to the patient's body, so the incidence of postoperative complications is high, which is not conducive to the function recovery of pancreatic tissue [7]. Therefore, the choice of a better and safer way to treat SAP complicated with pancreatic necrosis and infection has become a hot topic in clinical research. Percutaneous catheter drainage (PCD) is a minimally-invasive surgical technique, with advantages such as little trauma, short operation time, little complication, and low cost [8]. Previously reported PCD for SAP is mostly performed under the guidance of computed tomography (CT) [9, 10], and the ultrasound-guided PCD is relatively rare. This study investigated the efficacy of ultrasound-guided PCD in treatment of SAP complicated with pancreatic necrosis and infec-

tion. The objective was to provide a reference for further application of this technique to treatment of SAP.

Subjects and methods

Subjects

A retrospective analysis was made on 80 patients with SAP complicated with pancreatic necrosis and infection in our hospital from February 2013 to November 2017. There were 54 males and 26 females. The age of patients was 34-67 years, with average of 47.22±5.71 years. There were 46 cases of biliary pancreatitis, 29 cases alcoholic pancreatitis, and 5 cases of pancreatitis due to other reasons. The time from onset was 19.37±4.45 days. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was 11.63±3.92 points. The Balthazar CT score was 7.53±2.43 points. In necrotic tissue density by computed tomography CT, there were 40 cases with necrotic tissue density ≤ 20 Hu, 25 cases between 20 and 30 Hu, and 25 cases ≥ 30 Hu. The CT distribution range was 5.56±2.03 cm. This study was approved by the ethics committee of Chaoyang Hospital, Capital Medical University. Written informed consent was obtained from all participants.

Inclusion criteria and exclusion criteria

The inclusion criteria were as follows: i) the disease conformed to diagnostic standard of SAP combined with pancreatic necrosis and infection in the Guidelines for Diagnosis and Treatment of SAP issued by the Surgery Branch of the Chinese Medical Association; ii) the disease was confirmed by imaging results combined with bacterial culture; iii) the patients had complete data for statistical analysis. The exclusion criteria were as follows: i) the patients with previous history of laparotomy; ii) the patients with recurrent chronic pancreatitis; iii) SAP complicated with pancreatic necrosis and infection caused by trauma or surgery.

Grouping and treatment

According to the treatment method, 80 patients were divided into the control group (42 cases) and the observation group (38 cases). The patients in the observation group received PCD. Routine CT scan was performed before operation to clarify the relationship between the lesion and surrounding vessels and organs. After local anesthesia with 1% lidocaine, the puncture point was selected. Under guidance by ultrasound, the puncture needle was inserted into the pancreatic necrotic tissue, and the 14 F drainage tube was inserted. The sinus tract was dilated with a dilator along the guide wire. More than one drainage tubes were used for multiple or split necrotic tissue. After successful catheterization, the liquid necrotic tissue was exhausted. The bacterial culture was performed, and the use of antibiotics was adjusted according to the result of drug sensitivity. The solid necrotic tissue was flushed the next day with sterile saline for 4-8 hour each time. Generally, the drainage effect was assessed three days after PCD treatment, including general condition assessment and total abdominal CT examination. If the drainage tube was well positioned, the drainage was smooth, but the general condition was not alleviated, the treatment was timely transferred to open surgery. If the general condition was gradually alleviated, PCD was continued.

The patients in the control group received the open abdominal drainage. After confirming the lesion position, the routine disinfection was performed, followed by local anesthesia with 1% lidocaine. The incision in the middle of abdomen was made, followed by direct laparotomy. The pancreatic capsule was incised for decompression, and the pancreatic bed was full relaxed. Necrotic pancreatic tissue was thoroughly cleared. The abdominal cavity was flushed using sterile saline. More than one drainage tube was placed in sites surrounding pancreatic bed, retroperitoneum and pelvis, then the abdominal cavity was closed and the incision was sutured. After surgery, continuous normal saline perfusion and drainage was performed. The bacterial culture of necrotic tissue was performed.

Observation indexes

Before treatment and one week after treatment, laboratory indicators including blood white blood cell (WBC), blood amylase, urinary amylase, blood glucose, and blood calcium were measured. Serum inflammatory indexes including procalcitonin, C-reactive protein (CRP), tumor necrosis factor-α (TNF-α), and

Table 1. General patient information in the two groups

Parameter	Control group	Observation group	t/χ^2	P
n	42	38		
Age (years)	46.73±5.12	48.04±6.29	1.026	0.308
Gender (male/female, n)	28/14	26/12	0.028	0.867
Disease constitution			2.002	0.367
Biliary pancreatitis	22	24		
Alcoholic pancreatitis	16	13		
Other	4	1		
Time from onset (days)	18.55±4.08	20.22±5.13	1.619	0.110
APACHE II score (points)	11.22±2.79	12.34±3.52	1.584	0.117
Balthazar CT score (points)	7.33±2.72	8.28±2.02	1.758	0.083
Necrotic tissue density by CT			1.163	0.559
≤ 20 Hu	22	18		
20-30 Hu	14	11		
≥ 30 Hu	6	9		
CT distribution range (cm)	6.13±2.45	5.22±1.88	1.849	0.068

APACHE II, Acute Physiology and Chronic Health Evaluation II; CT, computed tomography

Table 2. Comparison of treatment efficacy between the two groups

Group	Cured [n (%)]	Improved [n (%)]	Ineffective [n (%)]	Effective rate (%)
Control	22 (52.38)	12 (28.57)	8 (19.05)	34 (80.95)
Observation	21 (55.26)	11 (28.94)	6 (15.80)	32 (84.20)
χ^2				0.147
P				0.702

interleukin-6 (IL-6) were detected. In addition, the bacteria culture of drainage liquid was performed. The determination procedures were according to the instruction of kits. According to clinical symptoms and CT finding, the treatment efficacy was evaluated as follows: i) cured: the clinical symptoms and signs recovered to normal; the laboratory indicators recovered to normal; the CT examination indicated the disappearance of peri-pancreatic tissue effusion; ii) improved: the clinical symptoms and signs of patients were alleviated; the area of peri-pancreatic tissue effusion was significantly reduced; partial laboratory indicators did not returned to normal; iii) ineffective: the patient's condition continued to deteriorate, the open surgery was needed, or the patients died. In addition, hospitalization time, reoperation rate, and death/abandonment rate in two groups were observed.

Statistical analysis

All statistical analysis was carried out using SPSS 23.0 software (SPSS Inc., Chicago, IL, USA). The enumeration data are presented as number and rate, and were compared using χ^2 test. The measurement data are presented as mean±SD, and were compared using t-test. $P < 0.05$ was considered as statistically significant.

Results

General information of patients in two groups

General information of patients in two groups is shown in **Table 1**. There was no significant difference of age, gender, disease constitution, time from onset, APACHE II score, Balthazar CT score, necrotic tissue density by CT, or CT distribution range between the control and observation groups ($P > 0.05$).

Comparison of treatment efficacy between two groups

After treatment, there were 22 cured cases, 12 improved cases and 8 ineffective cases in control group, with 21 cured cases, 11 improved cases and 6 ineffective cases in observation group. The effective rate of treatment in the control and observation groups was 80.95% and 84.20%, respectively, with no significant difference between two groups ($P > 0.05$) (**Table 2**).

Comparison of hospitalization time, reoperation, and death/abandonment between two groups

The hospitalization time in the observation group was 6.27±1.08 weeks, which was significantly shorter than 8.46±2.16 weeks in the control group ($P < 0.01$). The death/abandonment rate in the observation group was 18.42%, which was significantly lower than 40.48% in the control group ($P < 0.05$). There was no significant difference of reoperation rate between the two groups ($P > 0.05$) (**Table 3**).

Table 3. Comparison of hospitalization time, reoperation and death/abandonment between the two groups

Group	Hospitalization time (weeks)	Reoperation [n (%)]	Death/abandonment [n (%)]
Control	8.46±2.16	21 (50.00)	17 (40.48)
Observation	6.27±1.08	17 (44.74)	7 (18.42)
t/χ^2	5.642	0.222	4.621
P	< 0.001	0.638	0.032

Table 4. Comparison of laboratory indicators between the two groups

Group	WBC (× 10^9/L)	Blood amylase (U/L)	Urinary amylase (U/L)	Blood glucose (mmol/L)	Blood calcium (mmol/L)
Control					
Before treatment	16.45±3.18	705.87±89.28	1302.67±245.92	10.45±3.23	1.95±0.45
After treatment	9.62±2.12*	120.78±23.93*	678.12±223.37*	7.21±1.78*	2.22±0.37*
Observation					
Before treatment	16.36±2.56	699.32±78.45	1289.28±221.12	10.52±2.67	2.26±0.35
After treatment	7.37±1.88*,#	78.12±18.73*,#	458.35±156.73*,#	6.45±2.21*,#	2.23±0.38*

*P < 0.05 compared with before treatment; #P < 0.05 compared with observation group. WBC, white blood cell.

Table 5. Comparison of inflammatory indexes between the two groups

Group	Procalcitonin (ng/ml)	CRP (μg/ml)	TNF-α (pg/ml)	IL-6 (μg/ml)
Control				
Before treatment	6.94±2.02	48.12±6.62	154.67±28.01	78.97±23.12
After treatment	4.67±0.96*	35.72±4.92*	100.57±17.67*	56.38±10.49*
Observation				
Before treatment	6.89±2.24	47.45±7.37	162.23±34.34	84.56±34.12
After treatment	3.17±0.76*,#	23.58±3.89*,#	68.89±15.86*,#	35.44±8.17*,#

*P < 0.05 compared with before treatment; #P < 0.05 compared with observation group. CRP, C-reactive protein; TNF-α, tumor necrosis factor-α; IL-6, interleukin-6.

Comparison of laboratory indicators between two groups

Before treatment, there was no significant difference of blood WBC, blood amylase, urinary amylase, blood glucose, or blood calcium between two groups (P > 0.05). After treatment the level of each index in each group was significantly lower than before treatment (P < 0.05). In addition, after treatment, the levels of blood WBC, blood amylase, urinary amylase, and blood glucose in observation group were significantly lower than those in control group, respectively (P < 0.05) (**Table 4**).

Comparison of inflammatory indexes between two groups

Before treatment, there was no significant difference of serum procalcitonin, CRP, TNF-α, or IL-6 level between two groups (P > 0.05). After treatment the level of each index in each group was significantly lower than before treatment (P < 0.05). In addition, after treatment, the level of each index in the observation group was significantly lower than the control group (P < 0.05) (**Table 5**).

Comparison of bacterial culture result between two groups

The bacterial culture results showed that, there were 12, 25, and 5 cases of gram-positive bacteria, gram-negative bacteria, and fungus in control group, respectively, with 8, 28 and 2 cases of gram-positive bacteria, gram-negative bacteria, and fungus in observation groups, respectively. There was no significant difference between two groups (P > 0.05) (**Table 6**).

Table 6. Comparison of bacterial culture result between the two groups [n (%)]

Group	Gram-positive bacteria	Gram-negative bacteria	Fungus
Control	12 (28.57)	25 (59.53)	5 (11.90)
Observation	8 (21.05)	28 (73.68)	2 (5.27)
t/χ^2		2.061	
P		0.357	

Discussion

SAP has acute onset and severe condition, and often involves multiple organs of the whole body. The treatment of SAP is complicated, and the mortality rate is high [11]. When the pancreatic necrosis and infection occur, the mortality of SAP patients is increased significantly [12]. In the past, the debridement and drainage performed during open surgery are often regarded as the gold standard for SAP with pancreatic necrosis and infection, but the mortality of patients is still high [13]. However, open surgery is a blow to patients who are already in poor condition. In addition, the high incidence of surgery-related complications is also an important reason for the treatment failure for patients with SAP [14]. The laparoscopic catheter lavage and drainage treatment is also used for SAP. It has better efficacy and less trauma, but it needs to be carried out under general anesthesia, and the surgical operation process is more complex [15]. Studies have shown that, the patients with CTSI ≤ 8.0 and with fewer serious complications can be conservatively treated, while the patients with CTSI > 8.0 should be treated with PCD or surgery because the conservative treatment may aggravate the fluid accumulation, tissue necrosis and other life-threatening complications [16, 17].

PCD, as a surgical drainage technique, can effectively drain the liquefied necrotic tissue, reduce the pressure in the thoracic and abdominal cavity, reduce the pressure of necrotic tissue, inhibit the absorption of bacterial toxins, thus alleviating the inflammatory response, and stabilizing the disease condition [9, 10]. This study compared the efficacy of ultrasound-guided PCD and open abdominal drainage in treatment of SAP complicated with pancreatic necrosis and infection. Results showed that, after treatment the levels of blood WBC, blood amylase, urinary amylase, and blood glucose and serum procalcitonin, CRP, TNF-α, and IL-6 levels in patients with PCD were significantly lower than those in patients with open abdominal drainage, respectively ($P < 0.05$), and the hospitalization time and death/abandonment rate in patients with PCD were significantly lower than those in patients with open abdominal drainage, respectively ($P < 0.05$). This indicates that, as a minimally-invasive surgery, PCD can accurately target the lesion, and effectively control the infection. It is a safe and effective way to treat SAP combined with pancreatic necrosis tissue infection.

A previous study [18] pointed out that, PCD can only replace part cases of open abdominal drainage in treating SAP. For patients with incomplete drainage after repeated catheterization, the treatment needs to be converted to open surgery. In the present study, the effective rate in the observation group was significantly higher than that in the control group, but the difference was not statistically significant ($P > 0.05$). There was no significant difference of bacterial culture result between the two groups ($P > 0.05$). This indicates that, when treating SAP patients with pancreatic necrosis and infection, PCD can achieve the efficacy equivalent to that in open abdominal drainage. PCD can effectively drain the effusion and toxic substances, reduce the absorption of bacteria and trypsin into the blood, and alleviate inflammatory reaction. It plays an important role in preventing abdominal infection and multiple organ failure and controlling the disease condition.

Ultrasound-guided PCD therapy is easy to operate, and can be carried out in bedside. It can facilitate multiple punctures, and is very suitable for patients with complex and changeable conditions [19]. In addition, ultrasound-guided PCD has no radiation harm to doctors and patients. During the operation, the puncture needle can be adjusted repeatedly according to the real-time ultrasound image to achieve the ideal drainage position. These are the advantages that CT guided PCD does not have. However, ultrasound-guided PCD has higher requirements for surgeons. The reason is that, retroperitoneal area showed by ultrasound is relatively unclear than CT, especially in obese

patients [20]. Therefore, surgeons are required not only to have solid knowledge of local anatomy, but also to have rich experience in ultrasound and puncture guidance.

In conclusion, PCD has significant efficacy in treatment of SAP patients with pancreatic necrosis and infection. It can effectively shorten the hospitalization time, reduce the death/abandonment rate, and improve the postoperative laboratory indicators, which is conducive to postoperative recovery of patients. This study still has some limitations. As this study is a retrospective analysis, the random allocation principle is not allocated to the patients. Furthermore, the sample size is relatively small. These issues may have influence on the persuasiveness of results, and should be solved in further studies.

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Disclosure of conflict of interest

None.

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