Analysis of the Application of Laparoscopic Peritoneal Lavage and Drainage in the Early Treatment of Severe Acute Pancreatitis

Hankun Yuan, MD, Wenxiang Liang, MD,* Shenglin You, MD,* Jiajie Zhou, MD,* Sizong Chen, MD,* Xijuan Tan, MD,* Qiyi Luo, MD,* Yufei Ma, MD,* Libai Lu, MD,*† Zongjiang Luo, MD,*† and Jianchu Wang, PhD*†*

Objective: To investigate the clinical efficacy of laparoscopic peritoneal lavage and drainage (LPLD) in the early stage of severe acute pancreatitis (SAP) and its potential role in reversing organ failure.

Methods: This study involved 79 patients diagnosed with severe acute pancreatitis with ascites, who were admitted to Affiliated Hospital of Youjiang Medical University for Nationalities between January 2020 and May 2024. Based on the intervention strategy, the patients were categorized into 2 groups: the abdominal paracentesis drainage (APD) group (n = 42) and the LPLD group (n = 37). We conducted a retrospective analysis comparing various parameters including demographic information, trends in inflammatory marker fluctuations, incidence of organ failure, step-up treatment, duration of ICU stay, drainage tube indwelling time, complications, total hospitalization days, total hospitalization cost, and mortality rates.

Results: In addition to the observation that the preoperative volume of ascites was significantly greater in the APD group compared with the LPLD group ($P = 0.005$), the baseline characteristics of both groups were comparable. Postoperatively, The white blood cell count and C-reactive protein levels in the LPLD group exhibited a significantly faster decline compared with those in the APD group ($P < 0.05$ and < 0.001). There were no statistically significant differences in the rates of hemodialysis, pancreatic pseudocyst, abdominal compartment syndrome (ACS), and mortality between the 2 patient groups ($P >$ 0.05). The LPLD group exhibited significantly reduced durations for mechanical ventilation, step-up treatment, duration of ICU stay, drainage tube indwelling time, duration of systemic inflammatory response syndrome (SIRS), incidence of intra-abdominal infection, new onset organ dysfunctions, total hospitalization days, and total hospitalization cost when compared with the APD group ($P < 0.05$).

Conclusions: In patients with SAP complicated by ascites, early-stage LPLD can effectively alleviate systemic inflammatory response, expedite organ failure reversal, delay disease progression, avoid step-up treatment, reduce postoperative complications, and shorten hospitalization duration. This minimally invasive therapeutic approach represents a promising strategy for early intervention in SAP.

Key Words: severe acute pancreatitis, ascites, laparoscopic peritoneal lavage and drainage, abdominal paracentesis drainage, organ failure

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From the *Department of Hepatobiliary Surgery, Affiliated Hospital of Youjiang Medical University for Nationalities, Baise, China; and †Guangxi Clinical Medical Research Center for Hepatobiliary Diseases, Affiliated Hospital of Youjiang Medical University for Nationalities, Baise, China.
H.Y., W.L. and S.Y contributed equally to this work and are considered co-first authors.
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Address correspondence to: Jianchu Wang, PhD, Affiliated Hospital of Youjiang Medical University for Nationalities, Baise 533000, Guangxi Province, China (e-mail: wjianchu@sina.com).

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Severe acute pancreatitis (SAP), characterized by its perilous onset, multitude of complications, and high mortality rate, has not only emerged as a pivotal focus in clinical research but also represents a significant challenge in treatment due to its complex nature involving multiorgan dysfunction, making it a critical disease that demands extensive medical attention and innovative therapeutic approaches.[1] The pathogenesis of pancreatitis includes abnormal activation of pancreatic enzymes, autodigestion of pancreatic parenchyma, and the cascade reaction of cytokines.[2] Among them, the cascade reaction of cytokines is the core factor leading to systemic inflammatory response syndrome (SIRS) and multiple organ dysfunction syndrome (MODS).[3] Research shows that the prognosis of pancreatitis mainly depends on the development of organ failure and the secondary infection of pancreatic or peripancreatic necrosis.[4] The bioactive substances in pancreatitis-associated ascetic fluid (PAAF) are the key factors in determining the course of acute pancreatitis.[5] Among pancreatitis patients, ~30%–40% will be complicated with PAAF. For patients with SAP, this proportion increases significantly and can be as high as 60%.[6] PAAF contains a large amount of harmful substances such as pancreatic enzymes, inflammatory mediators, and hemoglobin, which can upregulate the expression levels of inflammatory factors such as TNF-α, IL-1β, IL-6, IL-8 and cause cytokine storms to aggravate the systemic inflammatory response.[7,8] Therefore, removing PAAF to block the inflammatory cascade reaction is the key to preventing the further development of the inflammatory storm and organ failure.

Regarding whether PAAF needs intervention and the timing of intervention, many scholars still have intense disputes and discussions up to now. Some scholars believe that early peritoneal lavage and drainage can reduce the rate of operation, infection, and mortality, shorten the reversal time of organ failure, and reduce the incidence of new-onset organ failure.[9–15] Some studies also show that PAAF is a sterile effusion, which can be self-absorbed with the development of the disease course through conservative treatment and has nothing to do with the severity of the disease. Early intervention is not supported, and puncture and drainage may instead increase the risk of exogenous infection.[16–18] Some meta-analyses point out that peritoneal lavage cannot improve the prognosis of patients.[19,20] This may be related to the different severity of the diseases of the patients included in the study. Mild pancreatitis patients are less likely to benefit from peritoneal lavage, and there are various lavage methods, including lavage after necrosectomy, peritoneal dialysis, etc.[19] Judging from the current recommendations in pancreatitis guidelines, there are only indications for puncture and drainage or surgery when infected pancreatic necrosis (IPN), abdominal compartment syndrome (ACS), or persistent organ failure occur.[21] However, it is clinically found that when patients present with the abovementioned indications, they are mostly complicated with severe complications, which increases the difficulty of treatment and results in a worse prognosis.

At present, there are mainly three methods for peritoneal lavage and drainage in pancreatitis: (1) Continuous peritoneal catheter-inserted lavage and drainage. Relevant studies have pointed out[20] that a large amount of lavage fluid will cause the local inflammatory mediators in the abdominal cavity to spread and accelerate their absorption into the blood, and repeated lavage may remove beneficial inflammatory mediators, thus damaging the peritoneal defense mechanism. The article also points out that this method has a relatively high incidence of local complications, requires high-level nursing, is likely to aggravate the intra-abdominal pressure and abdominal distension symptoms of patients, and there is no significant evidence to improve the prognosis. Therefore, this method has been gradually phased out; (2) only perform puncture and drainage without lavage, including percutaneous catheter drainage (PCD) and abdominal paracentesis drainage (APD). The difference between the 2 is that PCD drains peripancreatic effusion while APD drains abdominal effusion. In recent years, many studies have proved that performing abdominal paracentesis drainage (APD) in the early stage of pancreatitis can effectively improve the prognosis of patients, reduce the mortality rate, and not increase the infection risk. APD has gradually become a transitional scheme before PCD in the "step-up" scheme[22,23]; (3) laparoscopic peritoneal lavage and drainage (LPLD). At present, this method is mainly used for the removal of peripancreatic effusion during pancreatic necrosectomy, ignoring the impact of abdominal effusion on the body. Moreover, under the delayed surgery strategy recommended by the guidelines, this method is less applied. Inspired by this, we thought about whether performing LPLD in the early stage of severe acute pancreatitis (SAP) without pancreatic necrosectomy can achieve clinical effects similar to or even better than those of APD. For this purpose, we collected the clinical data of SAP patients admitted to our hospital in recent years and adopted the method of retrospective control study to explore the clinical efficacy of early LPLD in the treatment of SAP and the prevention and treatment effects on organ failure and complications.

METHODS

Patient Information and Methods

A retrospective analysis was conducted on 79 patients with SAP complicated with ascites who were admitted to the Affiliated Hospital of Youjiang Medical University for Nationalities from January 2020 to May 2024. The severity of pancreatitis was based on the revised Atlanta classification,[24] which was divided into mild, moderately severe, and severe. Mild pancreatitis is the most common form, without involving organ failure or local or systemic complications, and usually subsides within the first week. Moderately severe pancreatitis was defined as the presence of transient organ failure, local complications, or aggravated comorbidities. SAP was defined as the presence of persistent organ failure, that is, organ failure >48 hours. Inclusion criteria: (1) diagnosed as SAP according to the 2014 Atlanta classification and definition; (2) age between 18 and 70 years; (3) admitted to the hospital within 72 hours of the onset; (4) presence of ascites ≥ 500 mL confirmed by abdominal ultrasound or CT. Exclusion criteria: (1) having received surgical intervention before seeking medical treatment; (2) diagnosed with malignant tumors and tumor-related ascites; (3) acute pancreatitis in pregnancy for more than 3 months; (4) pancreatitis caused by trauma or surgery; (5) chronic relapsing pancreatitis; (6) having chronic diseases with long-term associated ascites, such as liver cirrhosis, renal failure, cardiac insufficiency, etc. According to different intervention strategies, they are divided into the APD group and the LPLD group. This study was approved by the Medical Ethics Committee of the Affiliated Hospital of Youjiang Medical University for Nationalities (Grant No. YYFY-LL-2024-209), and all patients provided informed consent.

Intervention Strategies

After admission, all patients had their vital signs strictly monitored, underwent active fluid resuscitation, and were given treatments such as fasting, using somatostatin to inhibit gastric acid and pancreatic enzyme secretion, and analgesia. For patients with clinically suspected or confirmed infections, empirical antibiotic treatment was given. For patients with combined renal failure and respiratory failure, hemodialysis and mechanical ventilation-assisted respiration were carried out.

In the APD group, percutaneous paracentesis was performed under ultrasound guidance at the left or right paracolic sulcus as the selected puncture site. The puncture process ensured avoidance of important blood vessels and internal organs, followed by placement of one or two 12 F drainage tubes into either the abdominal cavity or pelvic cavity for effective drainage. The indications for removing the drainage tube include improvement of abdominal symptoms and signs, a drainage volume of less than 30 mL/d, and no clinical deterioration or accumulation of ascites as indicated by reexamination of abdominal ultrasound or CT.

In the LPLD group, the patient was positioned supine and underwent general anesthesia. The surgical field was routinely sterilized with drapery before inserting a 10 mm Trocar into the observation hole located at the lower edge of the umbilicus to establish an artificial pneumoperitoneum.

The abdominal cavity was meticulously explored, and then 3 cm below the xiphoid process and 5–10 cm below the costal margin of the left and right midclavicular lines were taken as operation holes. The fluid surrounding the liver, spleen, bilateral subphrenic space, pelvic cavity, and intestinal space was aspirated using a suction device. Subsequently, the abdominal cavity and pelvic cavity were thoroughly lavaged with a substantial volume of peritoneal dialysate until complete removal of inflammatory ascites was achieved. The lavage solution transitioned from turbidity to clarity. Following lavage, no active bleeding was observed in the surgical site, and 2–3 drainage tubes were inserted into Winslow foramen as well as the perihepatic and pelvic cavities. The puncture sites were meticulously sutured and closed while ensuring secure fixation of the drainage tube (Figs. 1, 2). The extubation criteria remained consistent with those applied in the APD group.

Data Collection

Collect the following data: (1) general clinical data: age, gender, comorbidities, etiology, preoperative ascites volume, SIRS, admission to the ICU, organ failure, and preoperative blood biochemical indicators; (2) use the Acute Physiology and Chronic Health Evaluation (APACHE) II score, the Modified Computed Tomography Severity Index (MCTSI) score, and the Marshall score to assess the severity of pancreatitis; (3) infection and inflammation indicators: the trends of changes in white blood cell (WBC) count and serum C-reactive protein (CRP) levels within 1–10 days after surgery; (4) Clinical outcome indicators: duration of mechanical ventilation, hemodialysis, step-up treatment, duration of ICU stay, drainage tube indwelling time, duration of SIRS, complications, total hospitalization days, total hospitalization cost, and mortality.

Statistical Analysis

The data were analyzed using Statistical Product and Service Solutions (SPSS) 27.0 software. Measurement data with a normal distribution were presented as mean ± SD, and the *t* test was employed for intergroup comparisons. For measurement data with a non-normal distribution, they are represented by median (interquartile range), and the Mann-Whitney test is used for comparison between groups. Count data were expressed as percentages (%), and the χ^2 test and Fisher test were used for intergroup comparisons. A significance level of $P < 0.05$ was considered statistically significant.

RESULTS

Comparison of General Clinical Data

The general clinical data of the 2 groups of patients are shown in Table 1. There were no significant differences between the 2 groups in terms of age, gender, comorbidities, etiology, severity scores, SIRS, admission to the ICU, organ failure and blood biochemistry ($P > 0.05$). However, the preoperative volume of ascites in the APD group was more than that in the LPLD group ($P = 0.005$).

Comparison of the Trend of WBC Count and Serum CRP Levels

As shown in Figure 3, within 3–7 days after the surgery, the decreasing speed of WBC count in the LPLD group was significantly faster than that in the APD group ($P < 0.05$). From the 3–10 days after the surgery, the serum CRP level in the LPLP group decreased significantly faster ($P < 0.001$).

Comparison of Clinical Outcome

There was no statistically significant difference in the incidences of hemodialysis, pancreatic pseudocyst, ACS, and mortality between the 2 groups of patients ($P > 0.05$). In the

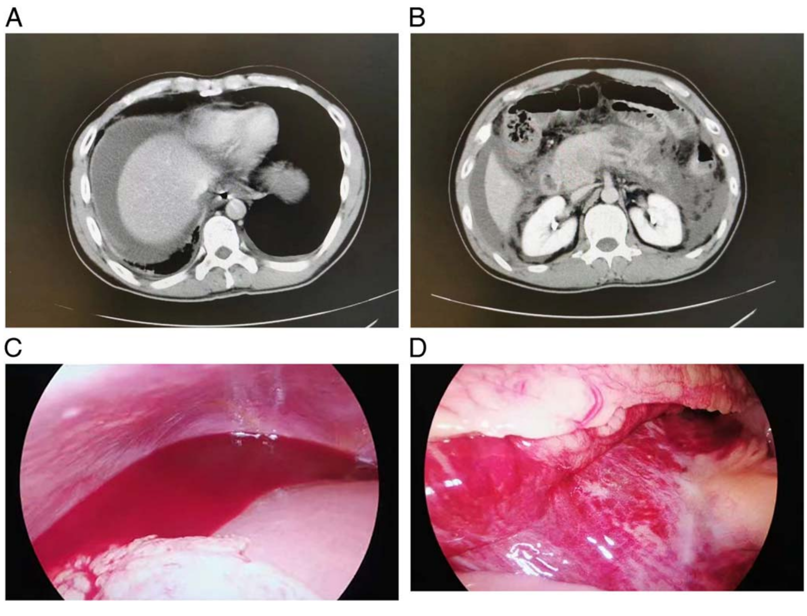

FIGURE 1. A 33-year-old male with acute hemorrhagic necrotizing pancreatitis complicated by multiple organ dysfunction and hyperkalemia. Perihepatic effusion was observed on CT imaging (A). CT revealed pancreatic swelling and necrosis of the body and tail (B). Laparoscopic exploration identified a significant amount of bloody effusion surrounding the liver (C). Laparoscopic exploration detected retroperitoneal swelling and hematoma (D).

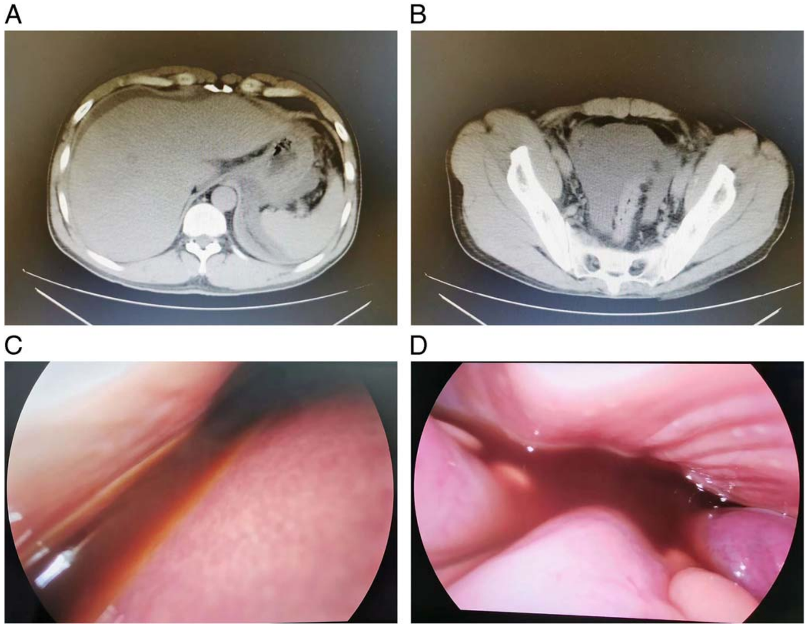

FIGURE 2. A 39-year-old male with acute pancreatitis. The upper abdominal CT scan revealed the presence of perihepatic effusion (A). The pelvic CT scan demonstrated the existence of pelvic effusion (B). Laparoscopic exploration unveiled a substantial volume of coffee-like and cloudy pancreatic ascites in both perihepatic and pelvic regions (C, D).

TABLE 1. Comparison of General Clinical Data

	APD group (n = 42)	LPLD group (n = 37)	*P*
Age	49.07 ± 10.93	51.03 ± 11.01	0.432
Sex			
Male	28 (66.7)	27 (73.0)	0.543
Female	14 (33.3)	10 (27.0)	
Comorbidities			
Hypertension	6 (14.3)	4 (10.8)	0.643
Diabetes mellitus	3 (7.1)	2 (5.4)	0.752
Others	2 (4.8)	2 (5.4)	0.896
Etiology			
Biliary	19 (45.2)	16 (43.2)	0.859
Hypertriglyceridemia	14 (33.3)	11 (29.7)	0.731
Alcoholic	7 (16.7)	5 (13.5)	0.697
Others	2 (4.8)	4 (10.8)	0.311
Severity score			
APACHE II score	15.76 ± 3.44	15.05 ± 4.49	0.431
MCTSI score	6.05 ± 1.62	5.89 ± 1.63	0.672
Marshall score	4.48 ± 1.35	4.13 ± 1.38	0.270
Volume of ascites	1521.43 ± 356.50	1313.51 ± 260.51	0.005
SIRS	29 (69.0)	23 (62.2)	0.520
Admitted to ICU	26 (61.9)	16 (43.2)	0.097
Organ failure			
Respiratory failure	15 (35.7)	12 (32.4)	0.759
Circulatory failure	17 (40.5)	17 (45.9)	0.624
AKI	8 (19.0)	6 (16.2)	0.742
Biochemical test			
Amylase (IU/L)	651.02 ± 275.81	628.11 ± 249.58	0.701
WBC count ($\times 10^9$/L)	15.08 ± 4.03	14.53 ± 3.22	0.510
CRP (mg/L)	166.45 ± 34.22	154.06 ± 36.83	0.125
Ca^{2+}(mmol/L)	1.87 ± 0.30	1.93 ± 0.24	0.332
Creatinine (μmol/L)	100.5(76.5–165.5)	103.0(73.5–148.5)	0.867

AKI indicates acute kidney injury; APACHE II, Acute Physiology and Chronic Health Evaluation II; APD, abdominal paracentesis drainage; CRP, C-reaction protein; ICU, intensive care unit; LPLD, laparoscopic peritoneal lavage and drainage; MCTSI, modified computed tomography severity index; SIRS, systemic inflammatory response syndrome.

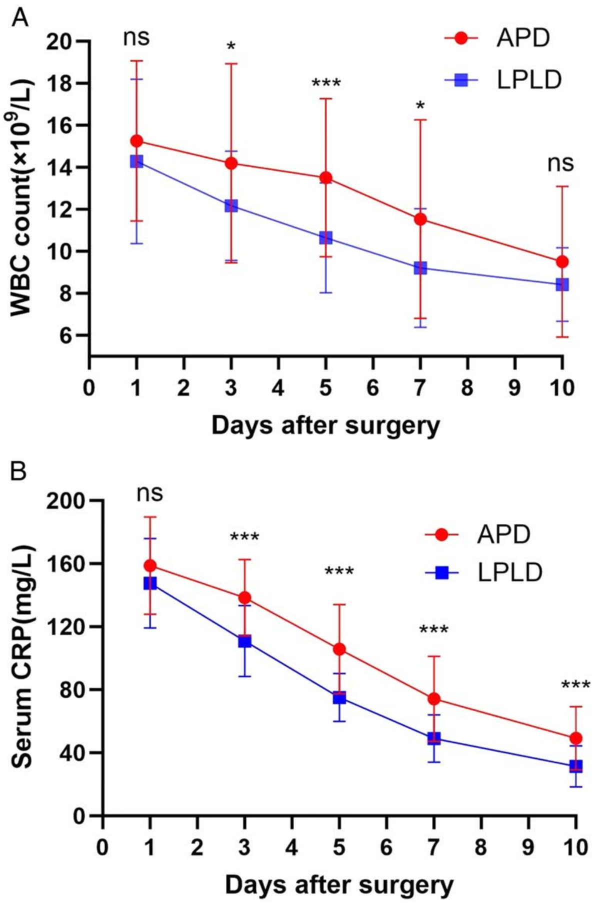

FIGURE 3. Comparison of the trend of WBC count and serum CRP levels. WBC count (A) and CRP level (B) decreased more quickly in the LPLD group than in the APD group. *$P < 0.05$, ***$P < 0.001$. ns indicates nonsense.

LPLD group, the duration of mechanical ventilation, step-up treatment, duration of ICU stay, indwelling time of drainage tube, duration of SIRS, incidences of intra-abdominal infection, and new-onset organ failure, total hospitalization days and total hospitalization cost were all significantly lower than those in the APD group, and the differences were statistically significant ($P < 0.05$, Table 2).

DISCUSSION

In pancreatitis, abnormal activation of pancreatic enzymes causes digestion of the pancreas itself and surrounding tissues, and in severe cases, it can lead to massive hemorrhage and necrosis of the pancreas and surrounding tissues. After the pancreatic injury, a large number of related proinflammatory cytokines such as IL-6, TNF, and prostaglandins are released, which increases vascular permeability, and coupled with a large amount of fluid resuscitation after admission, it leads to excessive exudation of fluid in the third space, so most SAP patients are often accompanied by a large amount of PAAF production within 24 hours.[6] In addition, peritoneal macrophages also secrete apoptosis inducing factors to participate in the generation of PAAF.[25] There are a large number of inflammatory factors in PAAF, and the long-term accumulation of ascites in the abdominal cavity will continuously cause local inflammatory reactions in the abdominal cavity, leading to intestinal mucosal damage, intestinal adhesion, and paralytic ileus, while the long-term stimulation of the intestinal wall by inflammation can increase its permeability and further lead to the translocation of intestinal flora to the abdominal cavity, increasing the risks of intra-abdominal infection and pancreatic necrosis.[26] A variety of inflammatory factors absorbed from the abdominal cavity into the blood are very likely to induce SIRS, and SIRS is an important pathophysiological basis for MODS.[27] A large amount of PAAF can not only cause intra-abdominal hypertension (IAH), leading to local microcirculation disorders in the pancreas and increasing the risks of pancreatic necrosis and infection, but also, when the intra-abdominal pressure is severely increased, it can lead to respiratory, circulatory and renal dysfunctions and even progress to ACS, seriously affecting the prognosis of patients.[28] Some studies have found that PAAF is lethally toxic, and in patients with early-stage acute pancreatitis complicated with ascites, the organ failure rate, pancreatic severity score, and mortality are significantly increased, with

TABLE 2. Comparison of Clinical Outcome

	APD group (n = 42)	LPLD group (n = 37)	P
Duration of mechanical ventilation (d)	8.48 ± 3.41	6.59 ± 3.03	0.012
Hemodialysis	12 (28.6)	8 (21.6)	0.478
Step-up treatment	11 (26.2)	3 (8.1)	0.036
Duration of ICU stay (d)	11.40 ± 4.26	8.92 ± 3.15	0.005
Indwelling time of drainage tube (d)	14.19 ± 4.25	10.78 ± 3.18	< 0.001
Duration of SIRS (d)	4.14 ± 1.09	3.16 ± 1.38	< 0.001
Complication			
Pancreatic pseudocyst	8 (19.0)	6 (16.2)	0.742
Intra-abdominal infection	13 (31.0)	4 (10.8)	0.030
New-onset organ failure	17 (40.5)	7 (18.9)	0.038
ACS	5 (11.9)	3 (8.1)	0.577
Total hospitalization days	31.12 ± 6.92	25.22 ± 5.23	< 0.001
Total hospitalization cost (RMB)	94322.55 ± 31025.55	79657.05 ± 27667.86	0.030
Mortality	3 (7.1)	0	0.097

ACS indicates abdominal compartment syndrome; APD, abdominal paracentesis drainage; ICU, intensive care unit; LPLD, laparoscopic peritoneal lavage and drainage; SIRS, systemic inflammatory response syndrome.

the mortality being 4 times that of those without ascites, moreover, the increase in the amount of ascites is related to poor clinical outcomes and is an important predictor of the severity of acute pancreatitis.[29–32] Therefore, theoretically, removing PAAF in the early stage of the SAP course can reduce the body's inflammatory response, improve organ functions, decrease the intra-abdominal pressure, and then improve the prognosis of patients.

In this study, the WBC count, CRP level, and the duration of SIRS in the LPLD group after surgery decreased significantly compared with those in the APD group, indicating that LPLD can effectively control the inflammatory response in SAP patients. The possible reasons for this analysis are as follows: Early LPLD can quickly remove the inflammatory exudate in the abdominal cavity, reduce the absorption of inflammatory factors into the blood, block the cascade reaction of the cytokine waterfall, and reduce the systemic inflammatory response. APD only has a drainage function, and the location of the tube placement is relatively limited and fixed. It may take several days to drain most of the exudate, and during this process, harmful substances are still continuously absorbed into the blood. Relatively slow drainage may keep the abdominal cavity at a mild intra-abdominal pressure, which may be helpful for the fluid to be discharged out of the body. However, it is difficult to drain the fluid in the lower part of the abdominal cavity and around the liver. The greater omentum is likely to cause blockage of the drainage tube. Repeated punctures, replacement of catheters, flushing, and delayed tube removal will increase the risk of infection and delay the treatment opportunity. For this reason, Huang et al[23] proposed the concept of "no-touching and off in time" for catheter management to solve this problem. Gupta et al[33] employed the technique of kissing catheters to solve the problem of drainage tube blockage. One catheter is used for flushing, and the other is used for draining and aspirating necrotic tissues, which improves the success rate of PCD. We also found that some patients in the APD group had incomplete drainage, and often required an extension of the drainage time to improve the prognosis. Therefore, the organ function recovered more slowly, and sometimes could not prevent the occurrence of organ dysfunction. As a result, the indwelling time of the drainage tube in the APD group was longer than that in the LPLD group. In addition, due to incomplete drainage, inflammatory ascites, and necrotic tissues are likely to be encapsulated to form pancreatic pseudocysts in the later stage of the disease course. It has been reported that in addition to the risks of catheter blockage and secondary intra-abdominal infection, APD may also face complications such as puncture site bleeding, abdominal cavity bleeding, and intestinal perforation,[34] but none of these were found in this study. Organ failure is the most important determinant of the prognosis of acute pancreatitis, with a mortality rate of about 30%. Organ failure occurs in 45% of patients with necrotizing pancreatitis.[27] The research results of Zeng et al[35] also suggest that renal failure and respiratory failure are related to the occurrence of ascites. Organ failure can occur within a few days after the onset of SAP, mainly related to the sterile inflammatory response, and late-stage organ failure may be related to sepsis caused by infected pancreatic necrosis.[1] In this study, the LPLD group was superior to the APD group in terms of the duration of mechanical ventilation and the incidence of new-onset organ failure. This suggests that performing LPLD in the early stage of the disease course can reduce the body's inflammatory state, improve organ function, and reverse early-stage organ failure. At present, many studies have proven that early drainage will not increase the risk of abdominal infection. The research results of our APD group are similar to those of Huang et al,[23] but the intra-abdominal infection rate in the LPLD group is lower. Because flushing the abdominal cavity with peritoneal dialysis fluid has a similar effect to peritoneal dialysis, most toxins and bacteria can be dialyzed out through flushing, which is helpful for reducing intestinal wall edema and the recovery of intestinal function and preventing the translocation of intestinal flora and the occurrence of infection. In addition, early postoperative tube removal may be another important factor for the low intra-abdominal infection rate.

In the past, surgical interventions for acute pancreatitis were mainly open-abdomen surgeries in the middle and late stages of the disease. Surgical debridement had a great impact on the functions of abdominal organs. Even if the surgical process was smooth, serious complications such as systemic infection, MODS, pancreatic fistula, and pancreatic exocrine dysfunction were extremely likely to occur after the surgery, and the mortality rate remained high.[36–38] With the development of minimally invasive techniques, a variety of minimally invasive surgical methods for treating acute pancreatitis, such as PCD, endoscopic debridement techniques, and laparoscopic techniques, have gradually been formed. On the basis of causing the least trauma to the human body, these methods can effectively control the development of acute pancreatitis and improve the prognosis of patients. Even so, the guidelines still adopt a delayed-intervention strategy for invasive operations. This not only restricts the innovative thinking of many surgeons in treatment plans but also limits the application of laparoscopic techniques in the early treatment of acute pancreatitis (AP) to a certain extent. LPLD is our new method for treating acute pancreatitis in recent years. In the early stage of SAP, LPLD is performed, and then drainage tubes are placed in the Winslow foramen, around the liver, and in the pelvic cavity. Our aim is only to remove inflammatory ascites and control the key factors that lead to the deterioration of SAP. The delayed intervention strategy in the guidelines is for the treatment of the pancreas, but we do not incise the omental bursa and posterior peritoneum, without necrosectomy. Because in the early stage of acute pancreatitis, the pancreas is aseptic necrosis, the boundary of the necrosis is unclear, and no infection has occurred yet. The exudation or necrosis in the retroperitoneum can be slowly encapsulated with the development of the disease course. The absorption of inflammatory factors in the retroperitoneal effusion is relatively slow and has a relatively small impact on the body. If the pancreatic capsule is incised, the inflammatory effusion around the pancreas will flow into the abdominal cavity instead, aggravating the inflammation in the abdominal cavity. In addition, excessive debridement and other operations interfering with the abdominal cavity in the early stage of acute pancreatitis are more likely to lead to the occurrence of complications such as bleeding, pancreatic leakage, gastrointestinal injury, and adhesive ileus, which also do not conform to the current guidelines for the treatment of pancreatitis. Only when the retroperitoneum is infected, the pressure is increased, or after the systemic acute inflammatory reaction has passed, the pancreas will be treated.

Under the concepts of minimally invasive and early intervention, we use LPLD for intervention in the early stage of SAP and find the following advantages: (1) laparoscopic surgery has less interference with the body, with short operation time, simple process and quick postoperative recovery; (2) under laparoscopy, the entire abdominal cavity and pelvic cavity can be explored, harmful inflammatory ascites in the abdominal cavity can be quickly removed, the absorption of inflammatory factors into the blood can be reduced, the local inflammation in the abdominal cavity and even the systemic inflammatory reaction can be alleviated, and thus organ damage can be reduced; (3) using peritoneal dialysis fluid to rinse the abdominal cavity can reduce the concentration of bacteria and toxins in the abdominal cavity, which is helpful for reducing intestinal wall edema and the recovery of intestinal function, and reducing the risk of infection caused by the translocation of intestinal flora; (4) APD has the disadvantage of incomplete drainage for multispace effusion. It is necessary to perform multisite puncture and catheter drainage. If the drainage is not smooth, the position of the drainage tube needs to be adjusted repeatedly. Sometimes, a larger-sized drainage tube needs to be replaced, which not only increases the risk of bleeding but also reduces the patient's tolerance to the operation. During LPLD, the drainage tube can be directly placed in the area where ascites accumulate or the low point of the abdominal cavity, and the diameter of the catheter is larger than that of APD, which can make the drainage more sufficient, and the postoperative drainage tube is not easily blocked by the omentum. (5) During pancreatitis, the omentum and abdominal wall are often severely adhered. APD needs to rely on the guidance of experienced imaging doctors to select a suitable and safe puncture channel under the guidance of ultrasound. There is a risk of damaging large blood vessels and important organs during the puncture and catheterization process, while LPLD is more suitable for patients without a safe puncture channel. (6) After LPLD, there is less peritoneal exudate, the extubation time is earlier, and the incidence of bacterial colonization and intra-abdominal infection is reduced.

However, LPLD may still have certain limitations. In the early stage of acute pancreatitis, exudates are mainly located in the retroperitoneum. Since the operation does not remove the exudates and necrosis in the retroperitoneum, it may increase the incidence of postoperative pancreatic pseudocysts. This problem can be effectively solved by subsequent PCD. Generally, people are afraid of general anesthesia surgery, resulting in a low acceptance rate of LPLD. However, local infiltration anesthesia APD still cannot effectively avoid pain, which also reduces patients' tolerance and comfort to the operation. Some studies have shown that general anesthesia may have the potential to reduce the postoperative systemic inflammatory response,[39] which may be beneficial for alleviating the inflammatory response of pancreatitis and the high-stress state of the body. We believe that the delayed surgical intervention strategy recommended by the guidelines is the greatest limitation for carrying out LPLD. This strategy aims to reduce the interference and damage to the pancreas and reduce the incidence of related complications and the mortality rate. LPLD only clears the ascites in the abdominal cavity and has less impact on the body. In this study, the LPLD group indeed showed a lower incidence of complications and mortality rate. However, the timing of the operation needs to be dynamically evaluated according to imaging examinations and the body's inflammatory response situation, and the intervention timing is generally within 7 days after the onset of abdominal effusion. In addition, the step-up treatment rate and duration of ICU stay in the LPLD group were significantly lower than those in the APD group. It can be speculated that early LPLD can relieve the condition to a certain extent and avoid further step-up treatment.

In summary, for patients with SAP complicated with ascites, performing LPLD in the early stage of the disease course can rapidly improve the body's inflammatory response, effectively shorten the reversal time of organ failure, delay the disease progression, avoid further step-up treatment, have fewer postoperative complications and a shorter hospitalization period. It is an effective minimally invasive treatment method and provides a new idea for the early treatment of SAP. However, the sample size in this study is relatively small, which is not conducive to fully revealing the potential advantages of the LPLD group in reducing complications and mortality rates. At the same time, it may also lead to bias in the research results. For example, APD patients usually have an indication for catheterization only when moderate or large amounts of ascites are present, and at this time, the patient's condition may be relatively severe. As a single-center, nonrandomized controlled study, the effectiveness and universality of the results of this study still need to be verified by more high-quality multicenter and large-scale sample studies.

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