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Open Vacuum Pressure Treatment of Pancreatic Necrosis

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Objective: Pancreatic necrosis is defined as acute necrotic collection and it occurs in 15-25% of patients with acute pancreatitis. Aim of this study is to investigate the use of marsupialization of omental bursa in combination with the semi-open packaging method to draining infected fluid collected from the omental bursa by suction pressure. **Methods:** We have performed a retrospective chart review of patients admitted to the General Surgery Department and Gastroenterology Department of The Third Central Hospital, and The First Central Hospital in Ulaanbaatar from November 1, 2008, to January 1, 2020, admitted with acute pancreatitis. After the complete debridement and lavage , upper and lower omental edges of the gastro-colic ligament were sewed to the peritoneum of upper and lower wound edges and negative pressure vacuum assisted closure was performed. **Results:** 155 patients aged 25-65 years participated in this study. The mean age was 38.98 ± 5.47, with 131 men (85%) and 24 women (15%). Post-opertaive complications occured in 118 (76.1%) cases of pancreatic necrosis after open surgery: the rate of complications was 45.8% in open packing, 21.3% in temporary closure, and 32.9% in vacuum closure. Wound healing time was 50.2 ± 3.6 in the open packing, while this time was shorted in both temporary closure and vacuum closure procedures (27.5 ± 3.05 and 28.1 ± 1.7, respectively). **Conclusion:** For pancreatic necrosis and inflammation, the use of marsupialization and semi-closed vacuum therapy reduces the number of recurrent surgeries with fewer complications. The postoperative wound closure of vacuum suction, was twice as short as open surgery (28.1 ± 1.7 days).

Keywords: Pancreatitides, Acute Edematous, Necrosis, Alcoholic

Introduction

Pancreatic necrosis is defined as acute necrotic collection and it occurs in 15-25% of patients with acute pancreatitis. It is the most serious complications and the mortality rate can be 100% if there is not surgical interventions. Cholelithiasis as well as exsecive alcohol intake are the main risk factors [1-3]. The Revised Atlanta Classification divides pancreatitis into eraly and late phases. In an early stage, there occurs inflammation with variable degrees of peripancreatic edema and ischemia to permanent necrosis and liquefaction. While, a late stage begins after the 1st week and could be extended for longer, and is

characterized by increasing necrosis, infection, and persistent multiorgan failure [4].

Management of pancreatitic necrosis complications is highly dependent on the severity, which is determined by consensus-based classification system of Revised Atlanta Classification, and the types such as pancreatic pseudocyst, hemorrhage, abscess and fistulas [5]. The infections of the pancreatitis (fever, leukocytosis) can be established by the computed tomography (CT). In the early stage of pancreatitis, prophylactic antibiotics are generally reccomended, however, if there is an indications of the infections, surgical intervention is required. There are several surgical approaches for interventions: open surgery, percutaneous catheter placement, laparoscopic and retroperitoneoscopic surgery. In the surgical procedure, abdomen is opened with a cross-sectional incision and clearly identifiable necrotic tissue which is easily separable from surrounding viable tissue is removed. It has been demonstrated that open surgery during the early stage of pancreatitis can be associated with mortality rates up to 65%, while the surgical intervention in the late stage could decrease this mortality rate to 27% [6, 7]. It is postulated that 2-3 weeks after the onset of the pancreatitis, sequestrum will be formed, thus prevent the substantial morbidity [8, 9].

Despite the low mortality rate by late stage surgical interventions, pancreatic necrosis persists after the operation and fluid retention in the lower extremities is a major cause of reoperation. Tsiotos et al demonstrated that the open surgery was performed 1-7 times per person, while in the study by Nordback, surgery was performed 2-5 times per person [7, 10]. Re-operation also depends on the type of inflammation. Branum et al. performed 2-13 operations per person with necrotic inflammation with 84% infectious necrosis [11]. Twenty to forty percent of post-operations are performed using the closed washing method, which is performed at the time of pancreatic necrosis. This suggests that even if the abdomen is closed and sutured, the need for surgical reopening is high. In the study by Paye et al, 41% of the patients preceded reoperation due to the continuing sepsis with evidence of organ failure after 48 hour of maximal therapy, sepsis with undrained gastro-intestinal tract fistula, sepsis with evisceration and massive hemorrage exteriorized through a drain [12]. Further, Harris et al also revealed that 95.2% of the patients had a complication, with an average of three complications per patient. Common complications included sepsis (33%), renal failure (24%), and pneumonia (24%), and overall mortality rate was 14% with a mean follow-up of 469 days [13].

Even though the surgical mortality for acute necrotizing pancreatitis has been significantly reduced in recent decades, there is still lethal complications caused from infected pancreatic necrosis. Margulies et al reported 30% of mortality rate among patients who have undergone marsupialization for treatment of infected pancreatic necrosis. The death of the patients resulted from sepsis after an infected necrotic pancreas. The authors had concluded that open debridement of infected pancreatic necrosis as a life-saving maneuver and marsupialization as an effective means of open drainage [14]. Another study of Doglietto et al showed the comparison of closed treatment with the results of open treatment which uses laparostomy and marsupialization of the lesser sac in patients affected by secondary pancreatic infections. The incidence of major surgical complications was 55.5% in open treatment and 8.3% in closed treatment ($P = .001$). However, signs of recurrent or persistent sepsis observed were 5.6% in the open treatment, whilst it was 41.7% in the closed treatment. In detail, 7.7% vs 46.7% in patients with infected pancreatic necrosis and 0% vs 33.3% in patients with pancreatic abscess [15]. From this result, one can be hypothesized that despite the high rate of the frequency of major surgical complications, open drainage by means of laparostomy and marsupialization of the lesser sac much better controls pancreatic infection, which in turn reduces mortality rate due to persistent or recurrent sepsis in patients with acute pancreatitis.

As mentioned above, primary debridement open surgery of the necrotic pancreatic is good technique for reducing the mortality and substantial morbidity for severe necrotizing pancreatitis. Thus, in the present study, we aimed to investigate the use of marsupialization of omental bursa in combination with the semi-open packaging method to draining infected fluid collected from the lesser omental sac by suction pressure.

Materials and Methods

Study design and subjects

Our study was carried out using retrospective targeted sampling. From November 1, 2008, to January 1, 2020, 155 patients who were underwent to an open surgery with pancreatic necrosis in the General Surgery Department and Gastroenterology Department of Third Central Hospital in Ulaanbaatar, Mongolia.

After the debridement of necrotic tissue and the lavage, upper and lower omental edges of the gastro-colic ligament were sewed to the peritoneum of upper and lower wound edges to isolate lesser omental sac from abdominal cavity. Further, negative pressure vacuum assisted closure was performed from the omentalis minor with constant suction with a slight negative pressure.

Vacuum or negative pressure treatment method

We placed a flat silicone liner on the back wall of the stomach and over the large intestine to prevent the cavity wall from being absorbed by the polyurethane porcelain wall and sealed it with adhesive film (Photo-1). Then we have placed a special tube with a suction part on the porolon, sutured on all on all 4 sides with 3.0 Vicryl wire around the flat, round part of the tip and attached it to the porcelain (Photo-2). Suction power (50-200 mm Hg) and working hours were connected to the vacuum apparatus. For deep wounds with blood vessels in the wound area, the pressure was lowered to 75-100 mm Hg. There were two suction methods: single and continuous (Figure 3). Infiltrated foam should be replaced after 2-3 days (Figure 4). When the use of porolon (negative pressure) is no longer required, we closed the abdominal incision and continued monitoring and treatment with a tube wrapped around the pancreas.

Statistical analysis

Descriptive statistics, including frequency, percentages, mean, standard deviation (SD), median and range, were calculated to evaluate demographic and clinical characteristics.

Ethical statement

The study was approved by the Ethical Review Sub-Committee of Ach Medical School on May 15, 2020 (No. 2020/5/15). In the study, the medical histories of patients admitted to the hospital with AP diagnosis were obtained from the archives of The First Central Hospital and Third State Central Hospital. The patient's name was encrypted, no personal identifying information was used, and confidentiality was maintained.

Results

155 patients aged 25-65 years participated in this study. The mean age was 38.98 ± 5.47, with 131 men (85%) and 24 women (15%). As we postulated, the semi-open method is effective in aspirating the infected fluid collected under subcutaneous pressure from the lower ventricle.

Table 1. Postoperative complications of pancreatic necrosis.

Methode of surgery	Number	Percentage
Age, year (mean, SD)	45.1 ± 11.0	
Male	118	76.1
Open packing	71	45.8
Temporary closure	33	21.3
Vacuum closure	51	32.9
Total	155	100.0

Further, antibacterial bandages was used to protect the outside and inside from the spread of bacteria. The transparent plastic film allowed to check the color and condition of the wound from the outside. Bacteriological examination of the wound fluid was also conducted.

Post-opertaive complications occured in 118 (76.1%) cases of pancreatic necrosis after open surgery (Table 1). The complications varied on the type of surgery. In detail, the rate of complications was 45.8% in open packing, 21.3% in temporary closure, and 32.9% in vacuum closure. On the other hand, recurring rate of vacuum treatment was higher, and the correlation with the chi-square test is $p = 0.000$, confirming a statistically significant difference. Moreover, the mortality which is mainly due to complications from underlying non-surgical diseases was low after vacuum treatment.

In the Table 2, surgical interventions and reoperations due to postoperative complications are shown. A total of 185 double operations were performed in 98 patients. In one case, a person had six surgeries in addition to the first. In the open packing procedure, there were 58 cases of re-operation, whilst there were olny 11 cases in temporray closure.

The complications of the surgery type was summarized in Table 3. As shown here, the main causes were chronic pancreatic tissue necrosis, in which fluid is ingested with pancreatic juice. Subsequently, it leads to small abscesses, accumulation of new dead tissue, peritoneal bleeding and gastrointestinal perforations. In the open packing, the highest complication was abscesses and fluid in the lower abdomen cavity (59%) and in the temporary closure and continuous lavage (58%). However, in the vacuum closure, complications was 31%. In the case of accumulation of dead tissue, the highest case was in vacuum

Table 2. Surgical interventions and reoperations due to postoperative complications (descriptive statistics for 155 operations)

Surgery method	The number of patient who had surgery	The number of reoperation	p-value
Open packing	71 (45.8)	58 (59.1)	0.051
Temporary closure	33 (21.3)	11 (11.2)	
Vacuum closure	51 (32.9)	29 (29.5)	
Total	155 (100.0)	98 (100.0)	

Table 3. Complication of sugery type.

Complication	Type of surgery			
	Open packing	Temporary closure and continuous lavage	Vacuum closure	Total
	N (%)	N (%)	N (%)	N (%)
Abscesses and fluid in the lower abdomen cavity	42 (59.0)	19 (58.0)	16 (31.0)	77 (50.0)
Accumulation of dead tissue	15 (21.0)	8 (24.0)	28 (55.0)	51 (33.0)
Abdomenbleeding	9 (13.0)	3 (9.0)	5 (10.0)	17 (11.0)
Perforation of the colon	5 (7.0)	3 (9.0)	2 (4.0)	10 (6.0)
Total	71 (100.0)	33 (100.0)	51 (100.0)	155 (100.0)

Table 4. healing time in lower abdomen cavity after surgery (destrctive statistic).

Variable	Surgery method			p-value
	Open packing (n = 55)	Temporary closure (n = 27)	Vacuum closure (n = 48)	
	Mean ± SD	Mean ± SD	Mean ± SD	
Healing time	50.2±3.6	27.5±3.05	28.1±1.7	0.000

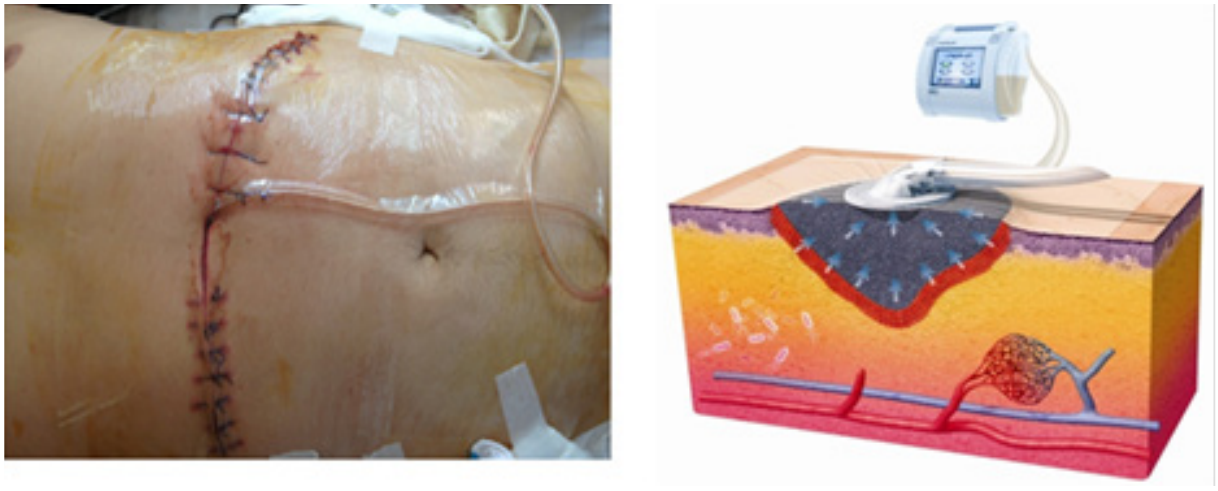

Figure 1. Placement of porolon porcelain in a marsupial space around the pancreas and glue it with a special film to create vacuum environment.

Figure 2. Placement of porolon in the marsupialized area.

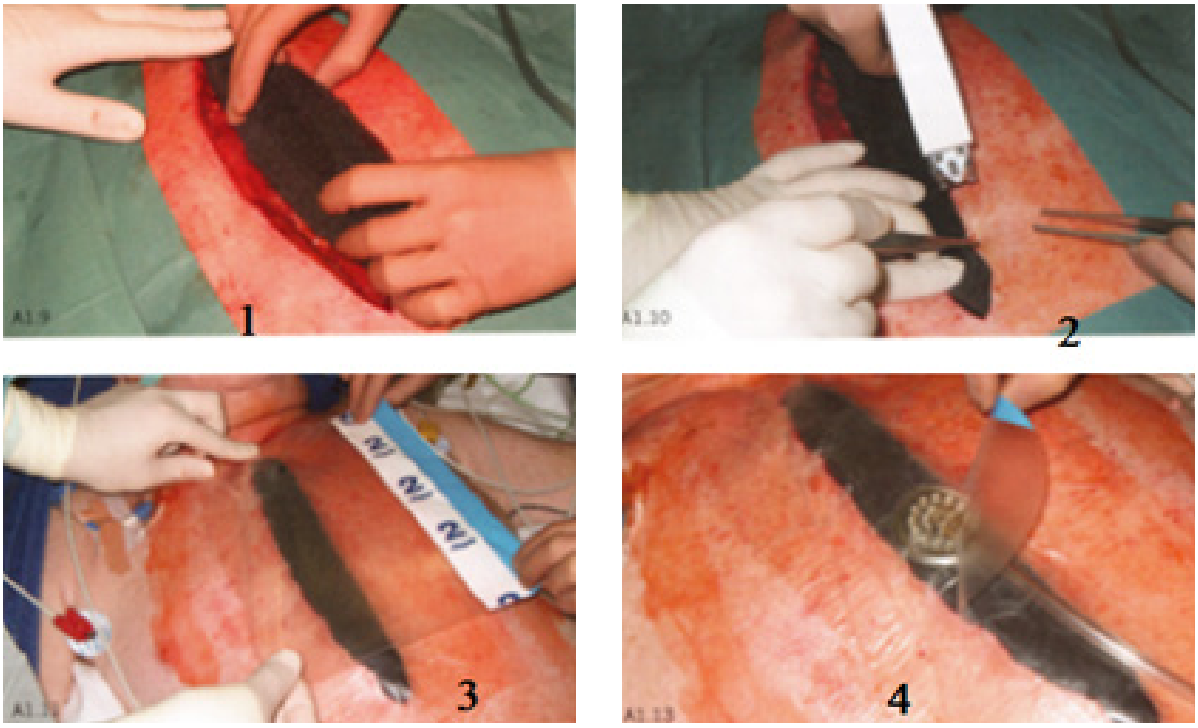

Figure 3. Put a black porolon on the abdomen that matches the shape of the wound; 1sew the edges of the wound to the bandage;2 stick the adhesive tape on the outside of the bandage; 3place the absorbent membran on the transparent membran.

closure, whilst there was 8 cases in the temporary closure and continous lavage. Because the dead tissue was completely removed in the temporarily closed method, the excretion of pus stopped early.

When the cleaning time is open, the time dependency or the P-value can be calculated for each of the three types of operation (Table 4). As shown here, the healing time was 50.2 ± 3.6 in the open packing, while this time was shorted in both temporary closure and vacuum closure procedures (27.5 ± 3.05 and 28.1 ± 1.7, respectively). Further, when the dressing is changed frequently, a double necrosis extractomy and lavage can be used to replace drainage.

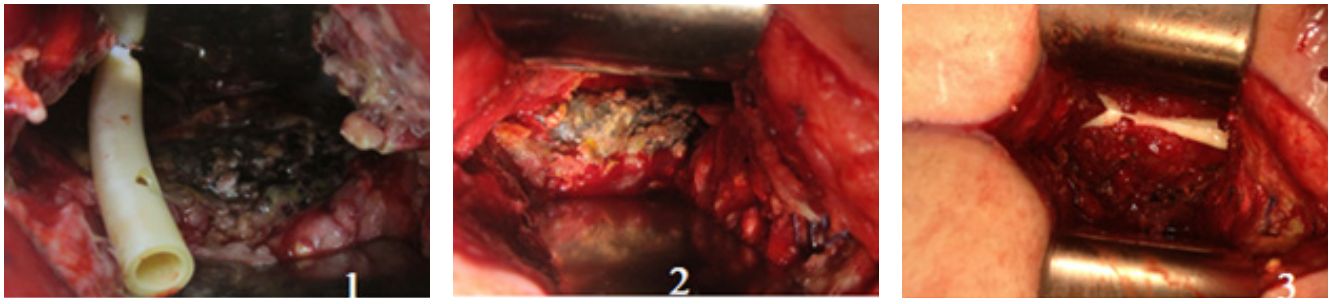

Figure 4. The newly introduced surgical technology has increased the sequestration of pancreaticnecrosis; 1. Pancreatic necrosis per surgery; 2. Pancreatic necrosis after 5 days of operation; 3. Full healing of pancreatic necrosis after 10 days of operation.

Discussion

Over the past decades, the management of the acute pancreatitis has undergone with significant evolution [16, 17]. Acute pancreatitis is classified based on Revised Atlanta Classification as mild, moderately severe and severe acute pancreatitis. The managements for the acute pancreatitis are the fluid resuscitation, enteral nutrition, antibiotics, and surgical interventions when there are detected infected pancreas necrosis. Numerous studies indicated that late stage surgical intervention is better than early stage operation due to the lower incidences of multi-organ failure, uncontrolled bleeding and sepsis [18-22]. If the infected necrosis stops expanding, there will be necrotic tissue liquification. Thus, the tissue liquification detected, percutaneous or endoscopic drainage of the infected collection is conducted. In the case of more serious collections, necrosectomy using minimally invasive approaches will be needed [23]. However, as reported by Bugiantella et al, open necrosectomy, which has been traditionally used for surgical treatment of pancreatic necrosis, was found to be associated with high mortality rates up to 40% [24]. Within the reason, it has become essential to improve surgical outcomes using different approaches with minimally invasive surgical techniques.

Even though, the mortality rates from surgery have diminished, a significant morbidity is still reported in patients undergoing open pancreatic debridement due to some complications such as the abdominal bleeding, colonic fistula, and progressive infection [25]. In our study, we have confirmed that post-opertaive complications occured in 76.1% of pancreatic necrosis after inflammatory surgery. The complications were varied in the type of surgery: 45.8% in open packing, 32.9% in vacuum closure. The main causes were chronic pancreatic tissue necrosis, in which fluid is ingested with pancreatic juice. In the open packing, the highest complication was abscesses and fluid in the lower abdomen cavity (59%). However, in the vacuum closure, complications was 31%. Sermoneta et al reported the use of intra-abdominal vacuum sealing after a classic necrosectomy and laparostomy. Two patients with diagnosis of severe acute pancreatitis were treated by necrosectomy, lesser sac marsupialisation and posterior lumbotomic opening. Both of the patients recovered from pancreatitis and a good healing of laparostomic wounds was obtained with the use of the vacuum-assisted closure system [26]. Another study by Olejnik et al showed significant reduction of morbidity and mortality with the use of the intra-abdominal vacuum assisted system in the treatment of localized pancreatic source of sepsis. The multi-center retrospective analysis revealed that surgery with combination of laparostomy, multiple irrigations and abdominal drainage resulted 5-18 repeat of laparotomies with debridement of the open abdominal wound in general anesthesia, while surgery with the addition of an intra-abdominal vacuum assisted negative pressure therapy system resulted 3-9 repeat. The mortality rate was 25.4% in the former procedure, while the mortality rate in the vacuum assisted negative pressure therapy system was 17.9% [27]. The vacuum-pack closures performed in 258 surgical patients resulted significantly good wound healing outcomes compared with primary closure of open abdominal wounds [28].

In the present study, surgical interventions and reoperations was performed in 98 patients. With the traditional open packing, the mostly occured complication was abscesses and fluid in the lower abdomen cavity (59%), whilst accumulation of dead tissue was main complication in the vacuum closure (28%). Moreover, there were only 2 cases of perforation of the colon in vacuum

closure compared with open packing (16 cases). Further, in most cases, a person had six surgeries in addition to the first. Cuschieri demonstrated that endoscopic retroperitoneal debridement resulted 88 procedures were performed in 24 patients with a median postoperative stay of 51 days and 25% mortality rate [29]. In the present study, on the other hand, with postoperative wound closure in vacuum suction, pancreatic necrosis was twice as short as open surgery (28.1 ± 1.7 days).

As new surgical and radiological technologies has been developed in recent decades, coordinated multidisciplinary care becomes even more important. Especially, in the severe acute pancreatitis, patients can develop pancreatic fluid collections including acute pancreatic fluid collections, pancreatic pseudocysts, acute necrotic collections, and walled-off necrosis. Subsequently, the management of these conditions is a key to decrease the post-operational complications as well as mortality rate. Latest reports demonsrated that surgery intervention in late stage seem to be safer procedure with good survival outcomes. Our study had limitation of the absence of standardized long-time follow-up. It could influence on association long-time morbidity, functional outcomes, and quality of life. The potential economical benefits and patient outcome improvement with regionalization of treatment of necrotized pancreatitis warrant further investigation.

Conclusions

For pancreatic necrosis and inflammation, the use of marsupials and semi-closed vacuum therapy reduces the number of repeated surgeries with fewer complications. Vacuum treatment of purulent effusions in the wound cavity removes necrotic toxins from the body and reduces mortality by preventing multiple organ failure. With postoperative wound closure and with vacuum suction, pancreatic necrosis is twice as short as open surgery (mean 25.7 ± 3.05, 28.1 ± 1.7 days).

Conflict of Interest

The authors state no conflict of interest.

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