ORIGINAL ARTICLE

Risk factors for morbidity in walled-off pancreatic necrosis and performance of continuous postoperative lavage: A single-center experience

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ABSTRACT

BACKGROUND: The aim of this study was to evaluate the risk factors for morbidity in cases of walled-off pancreatic necrosis (WOPN) and the performance of continuous postoperative lavage (CPL) for patients who demonstrated resistance to a minimally invasive approach.

METHODS: The study enrolled 19 of 28 consecutive patients with WOPN who underwent surgical treatment or an endoscopic necrosectomy at Sakarya University Education and Research Hospital. The patients were divided into 2 groups according to the length of time from the first diagnosis of acute pancreatitis (AP) (Group 1, n=19) to preoperation or endoscopic necrosectomy (Group 2) (n=19). All of the cases were retrospectively evaluated and compared in terms of demographic features, operative features, and complications.

RESULTS: No statistically significant difference was found between the number of complications or the duration of hospital stay in terms of age, body mass index, size of the walled-off pancreatic necrosis, American Society of Anesthesiologists score, Ranson's criteria, operation time, and duration from AP to endoscopic necrosectomy or operation ($p>0.05$). Performance of an endoscopic necrosectomy was determined to be correlated with a decrease in the number of complications (B=-0.626, 95% confidence interval [CI]: -0.956 to -0.296; $p<0.001$), and when a high neutrophil-to-lymphocyte ratio (NLR) was detected at first admission, the number of complications was greater (B=0.032, 95% CI: 0.009–0.055; $p=0.01$). Reproduction in a culture and male gender were found to be risk factors for a prolonged hospital stay (B=0.669, 95% CI: 0.365–0.973; $p<0.001$), (B=0.484, 95% CI: 0.190–0.778; $p=0.003$), respectively.

CONCLUSION: CPL is a safe and effective surgical treatment approach for WOPN. Reproduction in a culture, male gender, and a high NLR on first admission and a negative or not-available endoscopic necrosectomy were determined to be risk factors for a poor prognosis.

Keywords: Continuous postoperative lavage; necrosectomy; walled-off pancreatic necrosis.

INTRODUCTION

Walled-off pancreatic necrosis (WOPN) is a rare complication associated with acute necrotizing pancreatitis (ANP) and occurs in approximately 5% to 10% of ANP patients.[1,2] WOPN, an encapsulated collection of liquid or solid necrotic tissues that develops more than 4 weeks after the initial ANP, is associated with high rates of morbidity (40–80%) and mortality (10–28%).[3–5] WOPN can be sterile or infected, solitary or multiple, and tends to be limited to the pancreatic area, but at times, may be located distant from the peripancreatic tissue.[5,6]

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Endoscopic intervention or surgery is not recommended for asymptomatic, sterile necrosis patients or size of necrosis, site, and dissemination. Minimally invasive interventions, including endoscopic necrosectomy or cystoduodenostomy, transpapillary drainage, percutaneous drainage, and transluminal and percutaneous drainage, can be effective, first-line treatment approaches for the management of WOPN.[7–10] However, in patients with resistance to such minimal invasive methods, open or laparoscopic surgical methods, including necrosectomy, cholecystectomy, or debridement of pancreatic necrosis, can be performed.[11–14] In the present study, the aim was to present the risk factors connected with morbidity in cases of WOPN and to evaluate the performance of continuous postoperative lavage (CPL) in patients resistant to a minimally invasive approach.

MATERIALS AND METHODS

Patients and Ethics

This study was conducted in the surgery department of Sakarya University Education and Research Hospital using records from the period of August 2014 to December 2017. A total of 19 patients who were treated only for WOPN were eligible for the study. The patients were divided into 2 groups based on the length of time from the initial diagnosis of acute pancreatitis (AP) to surgical operation or endoscopic necrosectomy: the first group (Group 1) included patients who had a diagnosis of AP, and the second group (Group 2) comprised patients who had not yet undergone the surgical operation or endoscopic necrosectomy. All of the cases were retrospectively evaluated in terms of gender and age, body mass index (BMI), co-morbidities, duration from the time of initial diagnosis to operation or endoscopic necrosectomy, alterations in biochemical parameter values from the initial diagnosis to operation or endoscopic necrosectomy, the postoperative length of hospital stay, and postoperative complications. The ethical committee of Sakarya University Education and Research Hospital approved the study protocol.

Methodology

A total of 28 patients who had been treated for a pancreatic pseudocyst or WOPN were enrolled in the study. All of the patients had undergone an endoscopic necrosectomy or surgical treatment and were evaluated retrospectively. Patients whose data showed that they still had a pancreatic pseudocyst (n=9) were excluded from the study based on the exclusion criteria. The remaining 19 patients were divided into 2 groups:

- Group 1: First diagnosis of AP (AP group) (n=19), and
- Group 2: Preoperation or endoscopic necrosectomy group (after >4 weeks) (n=19)

Blood samples were taken from all of the patients at the time of first admission for AP and before the operation or endoscopic necrosectomy. WOPN was diagnosed according to contrast-enhanced computed tomography (CT) by an experienced radiologist in the hospital (Fig. 1). The 2 groups were compared statistically in terms of gender, age, BMI, co-morbidities, duration from initial diagnosis to operation or endoscopic necrosectomy, alterations in the levels of biochemical parameters from initial diagnosis to operation or endoscopic necrosectomy, the postoperative length of hospital stay, and postoperative complications. The risk factors associated with morbidity were also identified. The patients were followed up at intervals of 1 week, 1 month, and 6 months after being discharged from the hospital.

Inclusion Criteria

- Patient must be over 30 years of age,
- Patient must have biliary pancreatitis, with a diagnosis of WOPN according to contrast-enhanced CT,
- Patient must have normal hemodynamic parameters (PTZ/INR, aPTZ, etc.).

Exclusion Criteria

- Patients younger than 30 years of age,
- Patients with malignancy related to the pancreas, distal choledoch, duodenum, periampullary tm etc.),
- Patients with non-WOPN disease (pseudocyst, sterile necrosis of pancreas),
- Patients with immunosuppression, pregnancy, multiple-organ failure, bile duct injuries during endoscopic retrograde cholangiopancreatography.

Endoscopic Necrosectomy

An endoscopic necrosectomy was initiated after premedication with fentanyl and midazolam and a prophylactic intravenous dose of 1 g of ceftriaxone. The endoscopic necrosectomy was performed with a therapeutic duodenoscopy and under fluoroscopy by 2 experienced gastroenterologists.

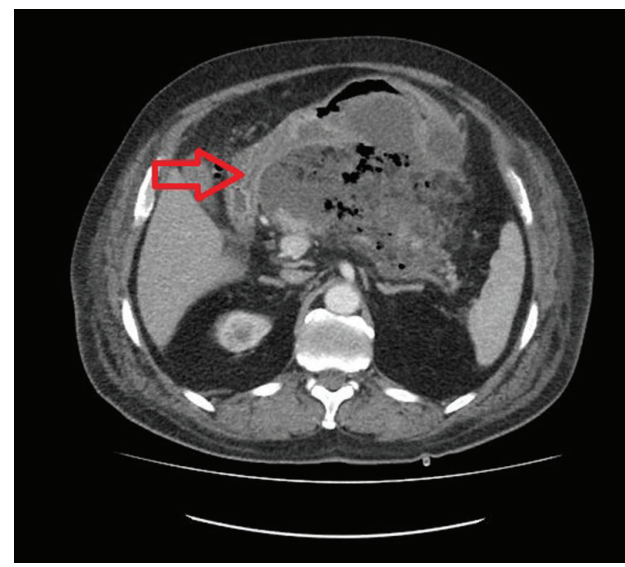

Figure 1. Walled-off pancreatic necrosis observed with computed tomography (red arrow).

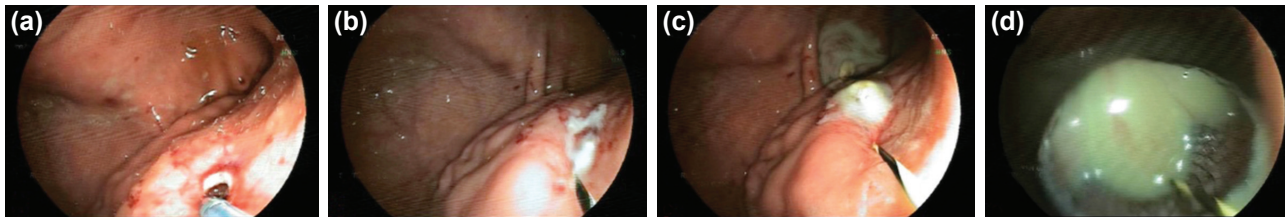

Figure 2. (a-d) Step-by-step endoscopic necrosectomy.

An incision was made with a cystotome from the side where the WOPN wall pressed on the stomach, and then the wall of the WOPN was cannulated with a 0.35-mm guidewire under fluoroscopy. The guidewire position in the WOPN was confirmed with contrast-enhanced fluoroscopy. The cannulated area was first dilated with a 10-F dilatator and then with a 12-mm balloon via guidewire. For those patients with pancreatic debris, a 7-F nasocystic drain was inserted to wash out the debris, and a Nagi stent (Niti-S self-expandable metal stent; TaeWoong Medical, Gyeonggi-do, South Korea) was inserted for drainage. A nasocystic drain was inserted into the WOPN and then washed with a solution of 20% hydrogen peroxide and 0.9% sodium chloride (NaCl) (150 cc), 3 times daily for a week in the hospital. The stent was removed after a week. Pancreatic debris was removed into the stomach with a 2.5-cm basket (Trapezoid RX; Boston Scientific Corp., Marlborough, MA, USA) and a retriever snare via gastroscopy. A 10-F double pigtail stent (5 to 7 cm) was inserted into the WOPN after the necrotic debris had been cleared in a total of 2 to 5 sequences. The step-by-step procedure is provided in Figure 2. The patients were followed up at 1-month, 3-month, and 6-month intervals. The stents were removed after the sixth month in patients who were asymptomatic and demonstrated a complete recovery. Four weeks after the removal of the stents, the follow-up was discontinued in patients whose contrast-enhanced CT results showed no necrosis.

Figure 3. Open surgery for walled-off pancreatic necrosis.

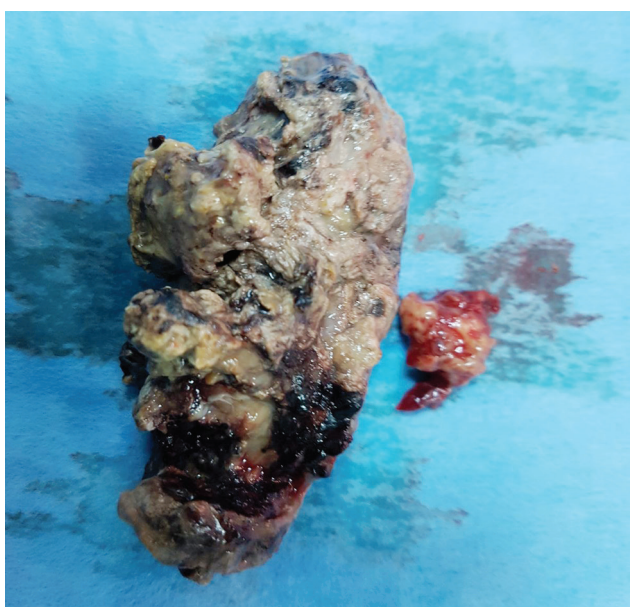

Figure 4. Pancreatic necrosectomy material.

Surgical Procedure and Continuous Postoperative Lavage[12]

The surgical procedure was performed in the standard fashion using an open approach with the patient in the supine position. After the administration of anesthesia, the laparotomy was initiated with a midline incision. The gastrocolic ligament was opened using 3/0 silk and an abdominal LigaSure device (Medtronic, Inc., Minneapolis, MN, USA) Debridement of necrotic tissue was carefully performed using hydrogen peroxide and 10% povidine iodine (Figs. 3 and 4). Hemostasis was obtained with bipolar electrocautery and 3/0 propylene sutures. After the necrosectomy, Calot's triangle was anatomically determined before the cystic artery and cystic duct were tied with 3/0 silk and then cut. The gallbladder was dissected away from the liver bed and removed. Hemostasis was obtained with bipolar and monopolar electrocautery. After achieving hemostasis, a total of 4 drains were inserted sub-hepatically, from the foramen of Winslow to the necrosectomy area (from right of midline, lesser sac), proximal to the spleen, and into the pancreatic area (from left of midline). The abdomen was typically closed afterwards, but in patients whose abdomen could not be closed due to dilated intestines and edema, Bogota's bag was used. The patients were then admitted to the intensive care unit. On the postoperative first day, local lavage, gradually increasing from 4 to 10 liters (0.9% NaCl) per 24 hours, was performed continually. Local lavage was administered from the left site drain and removed via the right site drains. The quantity of 0.9% NaCl used

was recorded. If the drains were not functional, they were improved manually. The process was continued until serous fluid was observed in the drains. The patients were followed up at 1-week, 1-month, 3- month, and 6-month intervals.

Statistical Analysis

The Shapiro-Wilk test was used to determine if the distribution of continuous variables was normal. The Levene test was used to evaluate the homogeneity of variances. Continuous variables were calculated as mean±SD, or median (min-max), as applicable. The number of cases and the percentage were used to describe categorical data.

The mean differences between groups were compared with Student's t-test, while the Mann-Whitney U test was applied for comparisons of non-normally distributed data. Categorical variables were evaluated using Fisher's exact test. Degrees of association between continuous variables were evaluated with Spearman's rank correlation analysis. To determine whether the differences in biochemical measurements between the preoperative or endoscopic necrosectomy and the diagnosis periods were statistically significant, a paired samples t-test, or Wilcoxon signed-rank test was used, as appropriate.

Multiple linear stepwise regression analyses were used to determine the best predictor(s) of the effect on the number of complications and duration of hospitalization. Any variable with a univariate test with a p value <0.10 was accepted as a candidate for the multivariable model, along with all variables of known clinical importance. The coefficient of regression, 95% confidence interval (CI), and a t-statistic for each independent variable were also calculated. As a result of non-normal distribution, logarithmic transformation was used for both the number of complications and the duration of hospitalization in regression analyses.

The data analysis was performed using SPSS Statistics for Windows, Version 17.0. (SPSS, Inc., Chicago, IL, USA). A p value of less than 0.05 was considered statistically significant.

RESULTS

Of a total of 28 patients, 19 were enrolled in the study, and 9 patients were excluded for failing to meet the inclusion criteria. The mean age of those included in the study was 60.9 years (±13.1; 32–81 years) and the group comprised 9 female and 10 male patients. The mean body mass index (BMI) was 26.2 kg/m^2 (±6.7 kg/m^2). Most of the patients (78.9%) had comorbidities: the most common were hypertension (57.9%), diabetes mellitus (26.3%), and congestive heart failure, or coronary artery disease (26.3%) (Table 1). Among all of the patients, there were 81.5% cases of abdominal pain, 62.2% cases with a loss of appetite, and 45% cases reporting nausea or vomiting at the first admission to the hospital.

Table 1. Clinical and operative characteristics and complications

Age (years)	60.9±13.1 (32–81)
Female/male	9/10
Comorbidities, n (%)	15 (78.9)
HT	11 (57.9)
CAP, CHF	5 (26.3)
DM	5 (26.3)
Hypothyroidism	1 (5.3)
Peripheral vascular disease	1 (5.3)
Ranson criteria (first admission), n (%)	
0	5 (26.3)
1	2 (10.5)
2	9 (47.4)
3	3 (15.8)
Total follow-up (months)	19 (4–41)
Duration time from AP to ENS or operation (days)	59 (30–335)
Size (cm)	11.6 (6–25)
Length of the hospital stay (days)	28 (10–82)
Operation time (min)	100 (70–180)
Preoperative ERCP, n (%)	9 (47.4)
Preoperative cholelithiasis, n (%)	19 (100.0)
Postoperative ERCP, n (%)	11 (57.9)
Endoscopic necrosectomy, n (%)	8 (42.1)
Surgical methods, n (%)	
Cholecystectomy	13 (68.4)
Necrozectomy and/or dedridman	13 (68.4)
Bogota bag	10 (52.6)
Right hemicolectomy and ileostomy	1 (5.2)
Gastrotomy, choledochotomy, and T-tube drainage	1 (5.2)
Number of complications	3 (0–6)
Total complications, n (%)	18 (94.7)
Reproduction of the culture	12 (63.2)
Readmission	11 (57.9)
Pancreas fistula	10 (52.6)
Surgical side infection	9 (47.4)
Atelectasis, effusion, and other	4 (21.1)
Reoperation	4 (21.1)
Recurrence	3 (15.7)

AP: Acute pancreatitis; CAP: Coronary artery disease; CHF: Congestive heart failure; DM: Diabetes mellitus; ENR: Endoscopic necrosectomy: HT: Hypertension.

The median follow-up time was 19 months (4–41 months), the median duration from AP diagnosis to endoscopic necrosectomy or operation was 59 days (30–335 days), the me-

Table 2. Alteration in biochemical parameters by group

	n	First diagnosis of AP	Preoperative or ENS	p	Range
CA 19-9	8	86 (2–376)	3.9 (2–23)	0.028†	-75 (-369.7–0.1)
Amylase	19	1800 (309–5286)	64.5 (18–292)	<0.001†	-1733 (-5257–-211)
Lipase	16	1225 (23–13395)	33 (8–246)	<0.001†	-1184.5 (-13285–3)
CRP	19	16.6 (0.1–151.0)	107 (3–298)	0.002†	69 (-25.3–171.6)
Glucose	19	155 (110–803)	117 (71–280)	0.006†	-27 (-523–67)
AST	19	143 (20–1646)	26 (11–84)	0.005†	-112 (-1626–51)
ALT	19	120 (12v1037)	17 (6–53)	0.002†	-85 (-1015–37)
T. Bilirubin	19	1.43 (0.29–8.75)	0.97 (0.29–14)	0.314†	-0.19 (-5.95–10.00)
D. Bilirubin	19	0.75 (0.05-4.09)	0.27 (0.1–7)	0.235†	-0.29 (-3.08–5.00)
LDH	19	378 (220–1743)	209 (158–497)	<0.001†	-130 (-1585–217)
Albumin	19	3.94±0.33	3.19±0.66	<0.001‡	-0.75±0.69
ALP	19	119 (49–242)	91 (3.2–1107)	0.103†	-29 (-204–1013)
GGT	19	189 (9–882)	33 (10–1119)	0.126†	-115 (-849–978)
Calcium	19	8.7 (7.3–10.3)	8.5 (4.6–9.7)	0.056†	-0.4 (-3.8–1.0)
Platelet count	19	202 (53.6–658)	249 (117–535)	0.494†	7 (-397–481.4)
NLR	19	7.6 (1.7–27.7)	2.5 (1.1–68)	0.061†	-3.1 (-16.8–48.2)
RDW	19	15.4 (13.4–18.9)	16.7 (14.1–19.3)	0.085†	0.8 (-3.9–5.2)
PDW	19	17.7 (13.2–22)	17.5 (16.6–19.6)	0.171†	-0.4 (-2.9–4.8)

†Wilcoxon signed-rank test; ‡Paired samples t-test. ALP: Alkaline phosphatase; ALT: Alanine transferase; AP: Acute pancreatitis; AST: Aspartate transferase; CA: Cancer antigen 19-9; CG: Cystogastrostomy; CRP: C-reactive protein; D. Bilirubin: Direct bilirubin; ENS: Endoscopic necrosectomy; GGT: Gamma glutamine transferase; LDH: Lactate dehydrogenase; NLR: Neutrophil-to-lymphocyte ratio; PDW: Platelet distribution width; RDW: Red blood distribution width; T. Bilirubin: Total bilirubin.

dian size of the WOPN was 11.6 cm (6–25 cm), and the median length of hospital stay was 28 days (10–82 days). All 19 (100.0%) of the patients had preoperative/endoscopy cholelithiasis, and 9 (47.4%) had a history of endoscopic retrograde cholangiopancreatography (ERCP). An endoscopic necrosectomy was performed on 8 (42.1%) patients. The median operation time was 100 minutes (70–180 minutes). The surgical methods used were cholecystectomy (68.4%), necrosectomy and/or debridement (68.4%), Bogota bag (52.6%), right hemicolectomy and ileostomy (5.2%), and gastrotomy, choledochotomy, and T-tube drainage (5.2%) (Table 1).

There were no cases of mortality in the study. Of the 19 patients, the rate of major complications was 78.9%. The most common complications were reproduction of the culture (63.2%), re-admission (57.9%), pancreatic fistula 10 (52.6%), surgical side infection (47.4%), atelectasia or pleural effusion (21.1%), and (21.1%), recurrence (15.7%). *Escherichia coli* (21%), *Staphylococcus spp.* (21%), *Candida albicans* (15.7%), and *Enterococcus faecalis* (15.7%) were the most observed growths seen at the surgical site or in the blood or urinary cultures. Those patients who were found to have these infections were referred to the infectious disease clinic and antibiotic treatment was initiated according their anti-biogram. Among the 19 patients, there were 7 grade A and 3 grade B pancreatic fistulas observed in the present study. The grade A pancreatic fistulas seen in the patients were a low-impact pancreatic fistula (<20–30 mL drainage), and the clinical course was uneventful with medical treatment. However, the grade B fistulas observed were high-impact pancreatic fistulas (>50–300 mL drainage) and had a symptomatic clinical course (fever, abdominal pain, surgical site infections). A somatostatin analogue was administered to the 3 patients with a grade B pancreatic fistula and total parenteral nutrition was used maintain their nutrition. The pancreatic fistulas were treated for 1 to 3 months with ERCP+ endoscopic sphincterotomy and plastic stents.

A surgical site infection was observed in a total of 9 (47.4%) patients. A wound culture was taken, prophylactic antibiotics were administered, and surgical site care was provided until complete healing was achieved.

The median amylase, lipase, C-reactive protein, cancer antigen 19-9, blood glucose, aspartate transaminase, alanine transaminase, and albumin levels measured at the first admission to the hospital were higher than they were at the time of the preoperative or pre-endoscopic necrosectomy, with a statistically significant difference found between the 2 groups ($p<0.05$) (Table 2). Table 3 demonstrates the relationship between certain characteristics of the patients, the number of complications, and the duration of hospitalization. When the

Table 3. Comparison of the number of complication and the length of hospital stay in terms of patient characteristics

	Number of complications	p†	Length of hospital stay	p†
Gender		0.968		0.095
Male	3 (0–6)		29.5 (22–82)	
Female	3 (1–6)		21 (10–40)	
Comorbidities		0.736		0.062
Yes	3 (0–6)		43.5 (28–82)	
No	3 (1–6)		23 (10–49)	
Hyperstension		0.968	0.968	
No	3 (0–6)		29.5 (10–82)	
Yes	3 (1–6)		28 (16–49)	
CAD, CHF		0.559		0.219
No	3 (0–6)		30.5 (15–82)	
Yes	3 (1–4)		23 (10–35)	
Diabetes mellitus		0.391	0.219	
No	3 (0–6)		25.5 (10–82)	
Yes	3 (1–6)		31 (23–49)	
Preoperative ERCP		0.661		0.182
No	3 (0–6)		33 (15–82)	
Yes	3 (1–6)		23 (10–56)	
Postoperative ERCP		0.351		0.272
No	3 (1–6)		31.5 (15–82)	
Yes	2 (0–6)		28 (10–49)	
ASA score ≥3		0.315		0.604
No	2 (0–6)		29.5 (15–82)	
Yes	3 (1–6)		28 (10–49)	
Endoscopic necrosectomy		0.005		0.177
No	3 (1–6)		31 (15–82)	
Yes	1 (0–3)		25.5 (10–35)	
Cholelithasis		–		–
No	0		0	
Yes	3 (0–6)		28 (10–82)	

†Mann-Whitney U test. ASA: American Society of Anesthesiologists; CAD: Coronary artery disease; CHF: Congestive heart failure; ERCP: Endoscopic retrograde cholangiopancreatography.

number of complications and duration of hospital stay were compared in terms of patient age, BMI, size of the WOPN, American Society of Anesthesiologists (ASA) score, Ranson's criteria, operation time, and the length of time from diagnosis of AP to the endoscopic necrosectomy or operation, no statistically significant difference was observed (p>0.05).

The risk factors related to the number of complications and duration of hospital stay were evaluated using multivariate linear regression analysis. The variables identified as candidate risk factors were included in a univariate linear regression model at p<0.10. Endoscopic necrosectomy and the neutrophil-to-lymphocyte ratio (NLR) at first admission were the most the decisive risk factors for the number of complications. The performance of an endoscopic necrosectomy was correlated with a reduced number of complications in these patients with WOPN (B=-0.626, 95% CI: -0.956 to -0.296; p<0.001). On the other hand, when a high NLR was detected at first admission, the number of complications increased (B=0.032, 95% CI: 0.009–0.055; p=0.01).

Reproduction in a culture and male gender were the most decisive risk factors for length of hospital stay. When the results were positive for reproduction in a culture, the length of the hospital stay increased (B=0.669, 95% CI: 0.365–0.973; p<0.001). Further, the length of hospital stay was longer

in males than in females (B=0.484, 95% CI: 0.190–0.778; p=0.003) (Tables 5 and 6).

DISCUSSION

The results of this study indicated that endoscopic necrosectomy reduced the number of complications, such as pancreatic fistula, readmission, reproduction in a culture, and surgical side infection. Furthermore, CPL of a necrotic area on a daily basis is safe and effective, and reduces mortality when endoscopic necrosectomy cannot be performed or is not available. In the present study, more than two-thirds of the patients were successfully treated with CPL and did not require another major abdominal surgery. The risk factors for prolonged length of hospital stay included patients with reproduction in a culture and male gender (p<0.001, p=0.003, respectively). A high NLR, which is generally seen as a predictive or prognostic factor in acute or chronic diseases, was determined to be a risk factor for complications (p=0.01). On the other hand, it was found that age, BMI, the size of the WOPN, the ASA score, Ranson's criteria, operation time, and duration from AP diagnosis to endoscopic necrosectomy or operation were not risk factors for complications or the length of hospital stay (p>0.05).

Table 4. Comparison between length of hospital stay and complications

	n	Length of hospital stay	p†
Pancreatic fistula			0.211
No	9	23 (10–40)	
Yes	10	30.5 (19–82)	
Surgical site infection			0.133
No	10	22.5 (10–49)	
Yes	9	31 (19–82)	
Atelectasis, effusion, and other			0.185
No	15	28 (10–56)	
Yes	4	35 (23–82)	
Reoperation			0.100
No	15	23 (10–56)	
Yes	4	33 (30–82)	
Readmission			0.310
No	8	29.5 (19–56)	
Yes	11	23 (10–82)	
Reproduction in culture			0.003
No	7	22 (10–28)	
Yes	12	33 (19–82)	
Recurrence			0.109
No	16	28 (10–82)	
Yes	3	35 (33–56)	

†Mann-Whitney U test.

Recently, minimally invasive interventions, including endoscopic ultrasound-guided transmural drainage, a double pigtail plastic stent (DPS), lumen-apposing metal stents (LAMS), straight biliary fully covered self-expandable metal stents, and percutaneous necrosectomy have been the preferred first-line approaches for the treatment of WOPN due to the lower morbidity rate associated with their use.[8–15] There have been many studies demonstrating the superiority of minimally invasive approaches in terms of effectiveness, safety, and morbidity. Sahar et al.[16] carried out a study comparing the results of DPS and LAMS used with percutaneous drainage in the treatment of WOPN with 25 patients in each group. The outcomes revealed similar technical success (100% vs 100%), time to resolution of WOPN (77 vs 63 days), length of hospital stay (14.5 vs 13.1 days), and adverse effects (24% vs 32%). These results suggested that LAMS do not appear to substantially improve DPS outcomes when combined with percutaneous drainage and they are associated with higher costs; therefore, their use should be discouraged.[16,17] Additionally, in a randomized clinical study comparing endoscopic transgastric necrosectomy and surgical necrosectomy for ANP conducted by Bakker et al.[18] that included 22 patients, the authors found that endoscopic necrosectomy decreased postoperative inflammation as measured by the cytokine in-

Table 5. Risk factors of complications and length of hospitalization

	Coefficient of regression	95% Confidence interval		t-statistic	p
		Lower limit	Upper limit		
Number of complications					
Endoscopic necrosectomy	-0.626	-0.956	-0.296	-4.020	<0.001
Neutrophil-to-lymphocyte ratio (first diagnosis)	0.032	0.009	0.055	2.935	0.010
Length of hospitalization					
Reproduction in culture	0.669	0.365	0.973	4.660	<0.001
Male gender	0.484	0.190	0.778	3.491	0.003

terleukin 6, as well as pancreatic fistula (10% vs 70%), and mortality and major morbidity (20% vs 80%).

A study comparing endoscopic drainage and surgical necrosectomy reported by Rana et al.[19] found that structural and functional impairment of the pancreas was seen less frequently in patients who had endoscopic drainage than in patients who underwent surgery due to the lower rates of diabetes (19.2% vs 44%), pancreatic fluid collection (3.8% vs 20%), and steatorrhea (3.8% vs 8%).

Although endoscopic or percutaneous interventions are related to decreased intervention time, hospital costs, pain, and morbidity, they may not always be possible or performed successfully every time. At Sakarya University Education and Research Hospital, endoscopic treatment approaches are performed by experienced gastroenterologists, but in patients with WOPN who have acute peritonitis or who are resistant to endoscopic intervention, the open surgery approach can be performed safely and effectively. The literature includes studies indicating the effectiveness of open surgery for WOPN.[19,20] In the open abdomen strategy, after necrosectomy and debridement, the abdomen is reopened every 1 to 3 days until all necrosis and/or infected material is removed. In the CPL approach, after necrosectomy and debridement, the abdomen is not reopened, and local lavage, gradually increasing from 4 to 10 liters per 24 hours, is performed continually. In 1988, Beger et al.[12] first described how CPL decreased morbidity and mortality in cases of ANP and demonstrated its excellent results. Of these 2 open surgical approaches, CPL is the most commonly performed worldwide.[20] A systematic review of 16 studies of ANP conducted by Nieuwenhuijs et al.[21] reported the following: mortality (27%), pancreatic fistula (21%), gastrointestinal fistula (20%), colonic necrosis (18%), hemorrhage (21%), incisional hernia (34%), and reoperation (66%). The review also found that the mean length of hospital stay in the intensive care unit (ICU) was 29 days. Nieuwenhuijs et al.[21] also conducted a review that involved 775 patients with ANP treated with CPL and reported the following: mortality (15%), pancreatic fistula (35%), gastrointestinal fistula (8%), colonic necrosis (2%), and hemorrhage (9%). Additionally, the mean length of hospital stay in the ICU was reported as 24 days.

Endoscopic necrosectomy is an effective first-line treatment approach for WOPN. However, in patients resistant to endoscopic necrosectomy procedures or if endoscopic drainage is unavailable, CPL can be a curative surgical treatment option, based on the results reported in the present study and in the literature. The effectiveness of the present surgical approach is attributed to the continuous washing of the necrotic area with 0.9% NaCl daily. Necrotic tissue debris related to inflammation mediators and cytokines was removed with this continuous lavage technique and ensured that the course of the WOPN treatment could be conducted safely and uneventfully.

In the present study, there were no cases of mortality, and the morbidities observed were similar to those reported in the literature. The following rates were found for the variables focused on in this study: reproduction of the culture (63.2%); readmission (57.9%); pancreas fistula (52.6%); surgical side infection (47.4%); atelectasis, effusion, and other (21.1%); reoperation (21.1%); and recurrence (15.7%).

This study's main limitations are that it was a retrospective study and that the study sample size was too small for a more detailed analysis.

Conclusion

CPL is a safe and effective surgical treatment approach for patients resistant to endoscopic necrosectomy procedures or unable to undergo endoscopic drainage in cases of WOPN. Reproduction in a culture, male gender, a high NLR measured at first admission, and negative or unavailable endoscopic necrosectomy are risk factors for poor outcomes.

Conflict of interest: None declared.

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ORİJİNAL ÇALIŞMA - *ÖZET*

Walled-off pankreatik nekrozda morbiditiye etki eden risk faktörleri ve ameliyat sonrası sürekli lavajın etkinliği: Tek merkez deneyimi

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AMAÇ: Walled-off pankreatik nekrozda (WOPN) morbiditeye eden risk faktörlerini değerlendirmeyi ve endoskopik nekrozektomiye dirençli hastalarda sürekli ameliyat sonrası lavajın etkilerini ortaya koymayı planladık.
GEREÇ VE YÖNTEM: Bu çalışmaya hastanemizde cerrahi tedavi veya endoskopik nekrozektomi yapılan 28 WOPN'li hastanın 19'u kabul edildi ve hastalar iki gruba ayrıldı; ilk akut pankreatit (AP) tanısı konulduğu zaman (Grup 1, n=19), operasyon veya endoskopik nekrozektomi yapılan zamana kadar (Grup 2, n=19). Hastalar demografik özellikleri, operasyon bulguları ve komplikasyonları açısından karşılaştırıldı.
BULGULAR: Hastalar hastanede kalış süresi ve komplikasyon arasında, yaş, vücut kitle indeksi, WOPN çapı, ASA skoru (American Society of Anesthesiologists), Ranson kriteri, operasyon zamanı, ilk başvuradan operasyon veya endoskopik nekrozektomi yapılan zamana kadar değerlendirildiğinde istatistiksel farklılık yoktu (p>0.05). Endoskopik nekrozektomi yapıldıkça komplikasyon sayısı azalmaktaydı (B=-0.626, %95 CI: -0.956–-0.296 ve p<0.001), ayrıca ilk başvurudaki nötrofil lenfosit oranı (NLR) düzeyi arttıkça komplikasyon sayısı artmaktaydı (B=0.032, %95 CI: 0.009–0.055 ve p=0.01). Kültürde üreme (B=0.669, %95 CI: 0.365–0.973 ve p<0.001) ve erkek cinsiyet (B=0.484, %95 CI: 0.190–0.778 ve p=0.003) hastanede kalış süresini arttıran risk faktörüydü.
TARTIŞMA: Sürekli ameliyat sonrası lavaj WOPN'de etkili ve güvenli bir cerrahi tedavi yöntemidir. Ayrıca, kültürde üreme, erkek cinsiyet, yüksek NLR düzeyi, yetersiz veya ulaşılamayan endoskopik nekrozektomi kötü prognoza etki eden risk faktörleridir.
Anahtar sözcükler: Nekrozektomi; ameliyat sonrası sürekli lavaj; walled-off pankreatik nekrozis.

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