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ORIGINAL ARTICLE

Aggressive Percutaneous Catheter Drainage Protocol for Necrotic Pancreatic Collections

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Abstract

Background Percutaneous catheter drainage (PCD) performed pro-actively for collections in acute pancreatitis (AP) is associated with better outcomes. However, there are only a few studies describing this protocol.

Aim We aimed to evaluate an aggressive PCD protocol.

Methods Consecutive patients with AP who underwent PCD with an aggressive protocol between January 2018 and January 2019 were included. This protocol involved catheter upsizing at a pre-specified interval (every 4–6 days) as well as drainage of all the new collections. The indications and technical details of PCD and clinical outcomes were compared with patients who underwent standard PCD.

Results Out of the 185 patients with AP evaluated during the study period, 110 (59.4%) underwent PCD, all with the aggressive protocol. The historical cohort of standard PCD comprised of 113 patients. There was no significant difference in the indication of PCD and interval from pain onset to PCD between the two groups. The mean number of catheters was significantly higher in the aggressive PCD group (1.86 ± 0.962 vs. 1.44 ± 0.667, $p = 0.002$). Additional catheters were inserted in 54.2% of patients in aggressive group vs. 36.2% in the standard group ($p = 0.006$). Length of hospital stay and intensive care unit (ICU) stay were significantly longer in the standard PCD group (34.3 ± 20.14 vs. 27.45 ± 14.2 days, $p < 0.001$ and 10.46 ± 12.29 vs. 4.12 ± 8.5, $p = 0.009$, respectively). There was no significant difference in mortality and surgery between the two groups.

Conclusion Aggressive PCD protocol results in reduced length of hospital stay and ICU stay and can reduce hospitalization costs.

Keywords Acute pancreatitis · Collection · Drainage · Percutaneous catheter drainage

Introduction

Acute pancreatitis (AP) is one of the commonest medical emergencies [1]. In its mild form, it has an excellent prognosis without significant morbidity or mortality. However, moderately severe or severe AP is associated with systemic and local complications that involve significant healthcare resource utilization. The most important local complication is the pancreatic fluid collection. Fluid collections are classified based on their duration and the presence or absence of necrotic contents [2]. Percutaneous catheter drainage (PCD) is an essential part of the management of patients with AP and necrotic collections [3–5]. Despite a recent increase in the utilization of endoscopic procedures, PCD remains the most commonly performed initial intervention in patients with AP and fluid collections. PCD serves as a gateway to

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video-assisted surgical procedures as well as percutaneous endoscopic necrosectomy. The PANTER trial showed that a minimally invasive step-up approach comprising initial PCD reduced the mortality as well as the rate of major complications when compared to open necrosectomy [6, 7]. In this trial, among the patients assigned to the step-up protocol, one-third could be treated with PCD alone. A few recent studies have shown a higher success rate with PCD alone [8–10]. A pro-active protocol that involves frequent catheter upsizing and insertions has been shown to improve the clinical success of PCD further [11–13]. However, these studies are limited by small numbers, different designs, and adoption of a protocol that is not universally applicable. We conducted this large single-center study to evaluate a pragmatic aggressive PCD protocol.

Methods

Patients

The institute ethics committee approved this study. We performed a retrospective evaluation of a prospectively acquired database of patients with AP at a tertiary care center. Written informed consent was obtained from all the patients at the time of the procedure. The study group comprised consecutive patients with AP who underwent PCD with an aggressive protocol from January 2018 to January 2019. We compared the outcomes with a historical cohort of patients who underwent PCD in a standard fashion. Patients with acute-on-chronic pancreatitis, history of previous drainage or surgery for pancreatitis-related complications, and those younger than 12 years were excluded.

Treatment Protocol

AP was diagnosed based on revised Atlanta criteria. The persistence of organ failure (defined by modified Marshal scoring system) beyond 48 h determined severe AP. Transient organ failure (< 48 h) characterized patients with moderately severe AP. Standard management in all the patients included fluid resuscitation, organ support, pain relief, and nutritional support. Contrast-enhanced computed tomography (CECT) of the abdomen was performed between 5 and 7 days after the pain onset. Antibiotic administration was indicated for extrapancreatic infections and suspected infection of the pancreatic necrosis (based on the presence of gas within the collection or worsening of patients' clinical course). The PCD fluid was sent for culture to establish the infection and guide further antibiotic therapy based on the sensitivity results.

PCD Protocol

All the PCDs were performed under ultrasound or CT guidance based on the location of the collection by interventional radiologists with 2–7 years of experience in non-vascular abdominal interventions. Seldinger technique was used for drainage. The initial access to the collection was obtained using an 18 G needle and 0.035″ stiff guidewire. The entry tract was dilated with fascial dilators. The catheter (either pigtail or Malecot catheter) was later placed over the guidewire. The catheter was secured in place using a suture. Flushing of PCD was done using normal saline (50–100 mL) at the bedside at least once daily. Besides, the interventional radiologist irrigated the catheter with the same volume of normal saline at the time of evaluation of patients. The catheter exchanges and upgradations were performed under USG guidance or fluoroscopy. Patients who failed to recover with PCD were subjected to minimally invasive surgical necrosectomy.

Aggressive PCD Protocol

The aggressive protocol was defined as PCD of all the drainable collections after an indication of drainage was identified. This protocol involved upsizing (every 4–6 days) to drain the entire collection, including both the liquid and the necrotic component.

Following the first PCD (14F), catheter upsizing was done every fourth to sixth day (with an increment of 2–4F in the caliber of the catheter). The maximum catheter size was 28F. The indications of a new PCD were: a new collection (not present on imaging that was done before or at the time of the first PCD) or significant extension of the collection to a different abdominal compartment. The catheter upsizing and/or insertion of new catheters was continued until there was fluid output of less than 20 mL for 48 h, resolution of organ failure and improvement in the inflammatory markers and imaging showed lack of residual collections.

PCD Protocol of the Comparison Group

The comparison group comprised patients who underwent PCD using a standard protocol in the previous 1 year. This protocol comprised of catheter insertion, followed by only scheduled re-intervention.

Following the first PCD (10F), catheter upsizing was performed only when there was a lack of improvement or deterioration in patients' condition, and the CT scan showed a significant residual collection or a new collection. The maximum catheter size used in this protocol was 16F. The

indication and method of catheter removal were the same as the pro-active group.

Imaging Follow-Up

Following PCD, patients underwent USG for the evaluation of collection every third day. In patients who had non-resolving organ failure or pressure symptoms, those who had clinical deterioration, and those in whom USG was non-diagnostic due to the deeper location of the collection, CECT was performed.

Assessment of Baseline Characteristics and Outcome Measures

The following parameters were compared between the two groups—demographic details, etiology, and severity of pancreatitis, pain to PCD interval, initial catheter size, catheter upsizing, additional PCD, total number of PCDs, maximum size of catheter, total duration of PCD, length of hospital stay, need for ICU stay, and length of ICU stay. Need for surgical interventions, in-hospital mortality, and complication rate were also compared.

Complications

The following complications were recorded: external pancreatic fistula (EPF, defined as drainage of more than 100 mL of clear pancreatic fluid for more than 3 weeks following PCD), inadvertent catheter removal, blockade of the catheter and intra-abdominal bleeding. An initial attempt at conservative management of EPF for 1–2 weeks was followed by pancreatic duct stenting. PCD was inserted through the same tract in patients who had inadvertent removal of the catheter. Persistent blockade of the catheter was managed with catheter upsizing. In patients with suspected intra-abdominal bleeding, CT angiography was performed, and further management was based on the imaging findings and patients' vital signs.

Results

Between January 2018 and January 2019, 185 patients were evaluated. Out of these, 110 (44%) patients underwent PCD, all with an aggressive protocol. The comparison group comprised of 113 patients.

There was no significant difference in the age of patients and the etiology of AP between the two groups. The mean age of the patients in the aggressive group was 38.41 ± 12 years compared with 38.59 ± 11.61 years in the comparison group ($p = 0.908$). The most common etiology was alcohol abuse in both groups. More patients in the aggressive groups had severe pancreatitis (79.1%) than the comparison group (60.2%), and the difference was statistically significant ($p = 0.008$). Similarly, the mean modified CTSI was higher for patients in the aggressive group (9.36 ± 1.0) than the comparison group (8.65 ± 1.9), and the difference was statistically significant ($p < 0.001$). Table 1 shows the baseline characteristics of the patients.

PCD Parameters

The mean time interval from onset of pain to the first PCD was 36 ± 43.22 days in the aggressive group compared with 25.18 ± 21.84 days in the comparison group. However, the difference was not statistically significant ($p = 0.430$). The mean number of catheters was significantly different between the two groups (1.86 ± 0.962 in the aggressive group vs. 1.44 ± 0.667 in the comparison group, $p = 0.002$). The maximum size of the catheter was significantly larger in the aggressive group than in the comparison group (18.36 Fr ± 7.8 Fr vs. 12.55 Fr ± 2.4 Fr, respectively). The patients in the aggressive group had a significantly shorter mean duration of drainage than the comparison group (24.65 ± 8.5 vs. 28.94 ± 22.55, $p < 0.001$). Additional catheters were inserted in 54.2% of patients in the aggressive group compared to 36.2% of patients in the comparison group ($p = 0.006$). Similarly, a significantly higher number of patients in the aggressive group had upgradation of the catheters compared to the other group (71.2% vs. 50%, $p = 0.001$). Table 2 depicts the PCD-related parameters in the two groups.

Table 1 Baseline characteristics of patients

Characteristic	Aggressive group (±SD)	Comparison group (±SD)	*p* value
Age in years (mean)	38.41 ± 12.0	38.59 ± 11.61	0.908
Gender			0.159
Male	78%	69.9%	
Female	22%	30.1%	
Etiology			0.921
Alcohol	48.1%	50.4%	
Gall stones	21.5%	33.6%	
Others	5%	3.5%	
Idiopathic	25.4%	12.5%	
Modified CTSI (mean)	9.36 ± 1.0	8.65 ± 1.9	< 0.001
Atlanta classification			0.008
Mild	2%	2.7%	
Moderately severe	19%	37.1%	
Severe	79%	60.2%	

CTSI CT Severity Index

Table 2 PCD parameters

Characteristic	Aggressive group (±SD)	Comparison group (±SD)	*p* value
Indication			
Suspected infection	33 (30%)	41 (36.2%)	0.131
Persistent organ failure	68 (61%)	60 (53.1%)	0.235
Pressure symptoms	9 (9%)	12 (10.7%)	0.312
Pain to PCD interval (days)	36.14 ± 43.22	25.18 ± 21.84	< 0.001
Mean number of PCDs	1.86 ± 0.162	1.44 ± 0.667	0.001
Mean total duration of PCD (days)	24.6 ± 8.5	28.9 ± 22.5	< 0.001
Upgradation of PCD	71.2%	50%	0.001
Additional PCD	54.2%	36.2%	0.006

PCD percutaneous catheter drainage

Table 3 Outcome and complications of PCD

Characteristic	Aggressive group (±SD)	Comparison group (±SD)	*p* value
Mean length of hospital stay (days)	27.45 ± 14.2	34.35 ± 20.4	0.001
Need for ICU stay	34.5%	62.8%	< 0.001
Mean length of ICU stay (days)	4.12 ± 8.5	10.46 ± 12.3	< 0.001
Surgery	9%	11.5%	0.554
Mortality	17.2%	13.3%	0.406
Complication			
EPF	29.09%	26.3%	0.412
Bleed	4.5%	3.9%	0.439
Blockade	13.6%	13%	0.406
Slippage	13.6%	10.2%	0.266

EPF extrapancreatic fistula, *ICU* intensive care unit

Outcome Parameters

The patients in the aggressive PCD group had a significantly shorter length of hospital stay compared to the comparison group (27.45 ± 14.2 vs. 34.35 ± 20.41 days, $p < 0.001$). A lesser number of patients in the aggressive group required ICU admission (34.5% as compared to 62.8%, $p < 0.001$). The mean duration of stay in the ICU was significantly shorter in the aggressive group than in the comparison group (4.12 ± 8.5 days vs. 10.46 ± 12.29 days, $p < 0.001$). However, there was no significant difference in terms of mortality and the need for surgical intervention between the two groups. Table 3 shows the outcome following PCD in the two groups.

Complications

There was no significant difference in the rate of complications between the two groups. EPF was seen in 29.09% of patients in the aggressive PCD protocol versus 26.3% of the patients in the comparison group. The catheter blockage and inadvertent removal occurred in 13.6% and 13.6% patients, respectively, in the aggressive PCD group and in 13% and 10.2% patients, respectively, in the comparison group. A few patients ($n = 3$, 2.7%) had both inadvertent catheter removal and blockage. Catheter site bleeding occurred in 4.5% and 3.9% of the patients, respectively, in the aggressive PCD group and the comparison group. An intervention was required for 5.5% of patients with EPF and 2.7% of patients with bleeding in the aggressive group. Both EPF and bleeding, requiring intervention, occurred in 2 patients (1.8%). There was no mortality related to PCD in either group.

Discussion

This study evaluated a relatively large number of patients who underwent PCD for necrotic pancreatic collections using an aggressive protocol. This PCD protocol involved frequent upsizing and new catheter insertions to achieve complete removal of the liquid as well as the necrotic component within all the collections. We found that this protocol can be easily incorporated into clinical practice. Compared with the historical cohort of patients (with comparable severity) who underwent standard PCD, aggressive PCD protocol led to a shorter length of hospitalization and ICU stay. Besides, fewer patients required ICU admission in the aggressive PCD group. Moreover, the complication rate was acceptable.

PCD is now considered an integral part of the "step-up approach" for the management of patients with AP and necrotic fluid collections [3–5]. The standard PCD protocol aims primarily at draining the fluid component of the collections, as was initially described in the PANTER trial [6, 7]. This approach involves placing a 10–12F catheter and allowing passive drainage of the liquid contents of the collection [6]. Lack of clinical improvement within a few

days of placement of PCD is considered as an indication for surgical necrosectomy. Collections that contain a lot of necrotic components are not adequately managed by this PCD protocol [14]. Recently, a pro-active PCD protocol has been advocated [11–13]. The pro-active protocol involves frequent catheter exchanges, upsizing, and lavage to drain the collections effectively. In comparison with the standard PCD protocol, this protocol involves the placement of multiple catheters and larger catheters [11]. This protocol has been shown to reduce mortality as well as the need for surgical necrosectomy [11–13]. No increase in the duration of hospital stay and significant complications or EPF has been reported in patients undergoing pro-active PCD [11–13].

However, only a few studies have described this protocol, and these studies included a limited number of patients [11–13]. The inclusion criteria in each of these studies were variable. In the study by Sugimoto et al. [12], PCD performed by a standard protocol at three different centers was compared with the pro-active PCD performed at one center. van Grinsen et al. [11] included data from the PANTER trial as the comparison group. In another study, the comparison was made with patients who did not undergo PCD [13]. One of these studies included only patients with infected necrosis, while the other two studies included patients with excessive leakage of pancreatic juices [11–13]. This limits the widespread applicability of these protocols. Our study is the largest study to describe a pragmatic PCD protocol that can be applied across the institutions.

In our study, a significantly higher mean number of catheters were inserted in the aggressive PCD group (1.86) than in the comparison group (1.45). However, in the study by van Grinsen et al. [11] there was no significant difference in the number of catheters inserted between the pro-active group and the comparison group. The median number of drains in both groups was 1. Sugimoto et al. [13] reported a mean of two CT-guided PCDs per patient in the pro-active group. The data from the comparison group were not provided. The number of patients undergoing additional PCDs and PCD upgradation was significantly higher in the pro-active group. van Grinsen et al. [11] and Sugimoto et al. [12, 13] did not mention the same in their studies.

We found that the length of hospital stay, need for ICU stay, and length of stay in the ICU in the aggressive PCD group were shorter than those in the comparison group. The study published by Ke et al. [8] did not find any significant difference in hospital stay or ICU stay between the pro-active group and the comparison group. Sugimoto et al. found that the patients in the pro-active protocol had a shorter duration of hospital stay and ICU stay as compared to the cohort of PANTER trial; however, they could not determine the statistical significance [9]. The hospital stay in the patients of our aggressive protocol is much shorter to that reported in the previous studies. Compared to the study by van Grinsven et al. and Sugimoto et al., the patients in our aggressive protocol had a greater need for ICU admission [8–10]. However, in the other study by Sugimoto et al. ICU admission was reported in 51% of patients in the pro-active protocol compared to 34.5% of the patients in our study [9]. This difference may be explained by the differences in the patient characteristics and institutional differences in the threshold for ICU admission.

We did not find any significant difference in the need for surgical interventions between the two groups. van Grinsen et al. [11] reported significantly lesser surgical interventions in the pro-active group compared to the standard group. However, a very high rate of surgical intervention (28.6%) was reported by van Grinsen et al. in their pro-active protocol compared to 9% in our protocol. This difference may partly be explained by the fact that all the patients in the study by van Grinsen had infected necrosis. On the other hand, none of the patients underwent necrosectomy in the two studies published by Mallick et al. [10] and Sugimoto et al. [11]. This may be due to the inclusion of patients who had uncontrolled leakage of the pancreatic juices for PCD in these studies, and this does not reflect the routine clinical practice. Additional necrosectomy has been reported in 13.3% of the patients undergoing PCD [10]. We did not find any significant difference in the mortality between the two groups. Similar results were reported by van Grinsen et al. and Sugimoto et al., with very low mortality (0% and 2%) for patients undergoing the pro-active protocol. This obviously cannot be entirely explained by the PCD protocol.

Our aggressive PCD protocol had a few differences compared to the ones described in the previous studies. In the studies by Sugimoto et al., the most common indication was excessive leakage of pancreatic juices as evidenced by persistent or enlarging fluid collection on CT [12, 13]. Organ failure and SIRS were documented in 26% and 62% patients, respectively [13]. Sugimoto et al. performed CT scans every third day following initial 12F PCD. A fluoroscopy study was performed after every CT scan to document the patency of the drain as well as to allow for catheter exchanges, upsizing, and repositioning. This led to extensive use of ionizing radiation. The maximum PCD size was 18F. A mean of two CT-guided PCDs per patient was obtained. In the study by van Grinsven et al. [11], PCD was done only for suspected or documented infections. Catheter upsizing and revisions were not performed according to a pre-specified time interval. This decision was rather based on the lack of clinical improvement. The median interval between the first and second PCD was 7 days, and the maximum catheter size was 20F. The median number of drains was 1. In the present study, the most common indication for PCD was persistent organ failure (61%) followed by suspected infections (30%) and pressure symptoms (9%). Compared to the previous studies, we performed catheter revisions/upsizing

every fourth to sixth day and did not routinely perform fluoroscopy. Additionally, CT scans were not performed before each catheter procedure. The initial catheter size (14F), as well as the maximum catheter size (28F), was larger than that of the previous studies.

In the present study, the most significant complications were EPF requiring intervention in 5.5% and intra-abdominal bleeding requiring intervention in 2.7% of the patients. van Grinsen et al. [11] found bleeding requiring intervention in 17% of patients. Sugimoto et al. [12] reported fistula requiring intervention in 10% and bleeding requiring intervention in 3% of the patients. These complications were comparable to those encountered in the standard PCD protocol in these studies.

The strengths of this study are a large cohort of patients in the aggressive PCD group as well as the comparison group. The technique of aggressive PCD involved catheter upgradation at pre-specified intervals. Unlike the previous protocols, patients were successfully managed without being exposed to CT scans each time before catheter upgradation. This makes this protocol pragmatic and acceptable and does not significantly increase the cost of healthcare resource utilization.

There are a few limitations to the study. The data are retrospective and hence have inherent limitations. The long-term follow-up is not available. The effect of the site and volume of collection is not considered [15]. Additionally, the impact of additional maneuvers like saline irrigation and antibiotic instillation has not been evaluated. Studies have shown these can be useful in further increasing the success of PCD [16, 17].

In conclusion, aggressive PCD protocol is feasible and has the potential to improve patient outcomes compared with the standard protocol. However, a randomized controlled trial with a predefined interval for catheter revisions as well as an irrigation protocol is required to compare the aggressive protocol with standard PCD protocol.

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Compliance with Ethical Standards

Conflict of interest The author declares that they have no conflict of interest.

Informed consent Procedural informed consent was obtained from all individual participants included in the study.

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