



Unusual Sites of Necrotic Collections in Acute Necrotizing Pancreatitis: Association with Parenchymal Necrosis and Clinical Outcomes

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Abstract

Background The presence of necrotic collection in acute necrotizing pancreatitis (ANP) at intra-abdominal sites other than the retroperitoneum has not been systematically studied.

Aim To investigate unusual sites of necrotic collections at computed tomography (CT) and to evaluate association with pancreatic necrosis and clinical outcomes.

Methods This retrospective study comprised of consecutive patients with ANP evaluated between January 2018 and March 2019. Based on CT findings, patients were divided into two groups: collections at unusual sites (small bowel mesentery, mesocolon, omentum, subcapsular collections along liver and spleen, pelvis, anterior abdominal wall, and inguinoscrotal regions) and collections at usual retroperitoneal locations (lesser sac, gastrosplenic location, anterior and posterior pararenal spaces, and paracolic gutters). The differences in CT findings and clinical outcomes (need for drainage, length of hospitalization, intensive care unit admission, surgery, and death) between the two groups were evaluated.

Results A total of 75 patients with ANP were evaluated. There were 25 (33.3%) patients with collections in unusual locations. These included mesentery ($n = 17$), splenic subcapsular location ($n = 7$), omentum ($n = 6$), hepatic subcapsular location ($n = 4$), anterior abdominal wall ($n = 3$), pelvis ($n = 2$), and inguinoscrotal location ($n = 1$). Compared to patients with collections at usual locations ($n = 50$), there were no differences in the CT findings except complete parenchymal necrosis (32% vs. 0%, $P = .001$). There were no statistically significant differences in the clinical outcomes between the two groups.

Conclusions Mesenteric collections are frequent in ANP. The other non-retroperitoneal sites are infrequently involved. There is no association between unusual sites of collection and clinical outcomes.

Keywords Acute pancreatitis · Computed tomography · Necrotic collection · Mesentery

Introduction

The majority of patients with acute necrotizing pancreatitis (ANP) have combined pancreatic and extrapancreatic necrosis (EPN) [1, 2]. Due to the retroperitoneal location of the pancreas, the extrapancreatic inflammation and resultant necrotic collections usually involve retroperitoneal spaces [2]. However, the spillage of pancreatic enzymes may lead to the involvement of sub-peritoneal and peritoneal spaces

and the formation of necrotic collections at these sites [3]. Available literature reports the uncommon sites of pseudocysts in the setting of chronic pancreatitis [4, 5]. However, the description of rare sites of necrotic collections in ANP is limited to case reports [6–10]. To the best of our knowledge, there is no published study systemically evaluating the sites of necrotic collections in acute pancreatitis. In the present study, we report the rare locations of necrotic collections and investigate whether there is an association of collections at unusual locations with the pattern of pancreatic necrosis. We also assessed whether there are any differences in the clinical outcomes between patients with necrotic collections at these unusual sites and those with necrotic collections at the usual locations.

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Materials and Methods

The institute ethics committee approved this retrospective study. Between January 2018 and March 2019, we evaluated consecutive patients with ANP for the presence of necrotic collections at unusual locations on computed tomography (CT) scans. Unusual locations were defined as small bowel mesentery, mesocolon, omentum, subcapsular collections along liver and spleen, pelvis, anterior abdominal wall, and inguinoscrotal regions (Fig. 1). Patients showing only inflammation without collection or loculated fluid without necrotic areas at the above-described locations were excluded. During the same period, patients with acute necrotizing pancreatitis showing necrotic collections at usual retroperitoneal locations (lesser sac, gastrosplenic location, anterior and posterior pararenal spaces, and paracolic gutters) were also included. These patients formed the comparison group.

CT Protocol

CT scans were performed on 64-, 128-, or 256-detector CT scanners, 65 s following intravenous injection of non-ionic iodinated contrast agent (omnipaque[®], GE Healthcare, USA) at a rate of 2.5 mL/s. The scans were acquired from the domes of the diaphragm to the symphysis pubis.

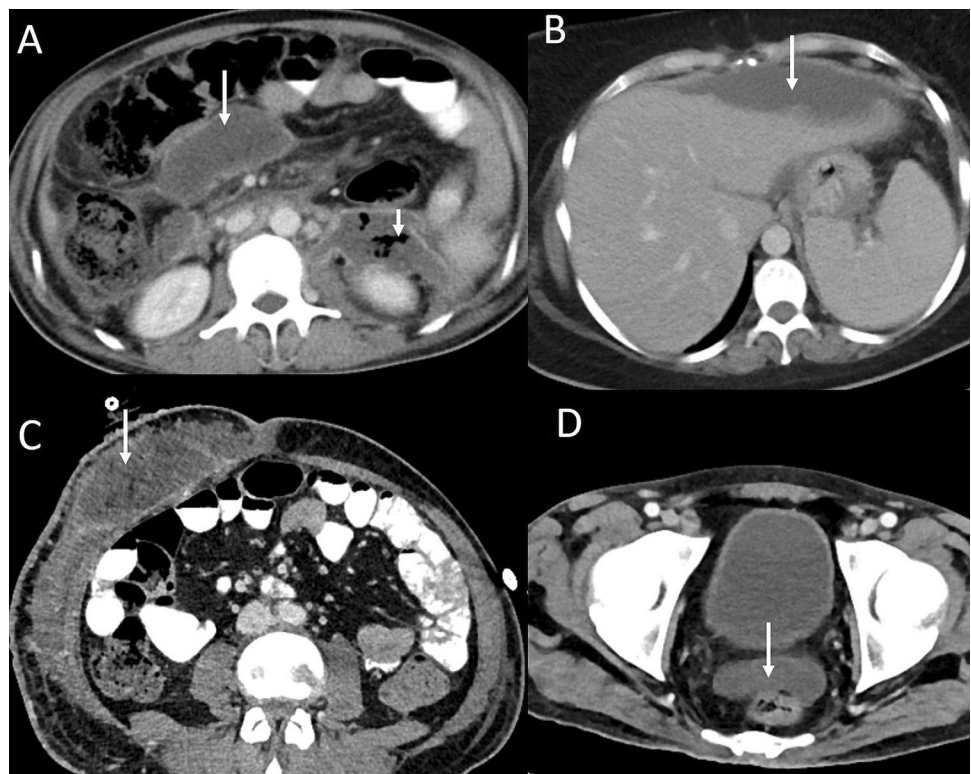
The initial available CT scan in each patient was assessed independently by two radiologists with 1 year and 5 years of experience in abdominal imaging. The radiologists were blinded to the clinical outcomes. The differences in opinion regarding the sites of the necrotic collection were resolved in consensus. Besides the location of collection, CT scans were also assessed for the degree of pancreatic necrosis (pancreatic necrosis was defined by the lack of enhancement of pancreatic parenchyma or attenuation less than 30 HU; divided into no necrosis, $\leq 50\%$, $> 50\%$, and complete necrosis), site of necrosis (head, body, tail, or multifocal), modified CT severity index (MCTSI), size and attenuation of collection, presence of ascites and pleural effusion.

Assessment of Clinical Outcome

The clinical outcomes were assessed by a gastroenterologist blinded to the CT findings. The need for drainage [percutaneous (PCD) or endoscopic], surgery, length of hospitalization (LOH), length of intensive care unit (ICU) stay, re-admission, and death was recorded.

The two groups [rare (group I) vs. usual location of the necrotic collection (group II)] were compared for differences in the various CT findings as well as the clinical outcomes. Additionally, subgroup analysis of group I for differences in the outcomes between patients with single versus multiple collections was performed.

Fig. 1 Uncommon sites of collection in patients with acute necrotizing pancreatitis. **A** Mesenteric collection (arrow) is seen. Additionally, there is a collection in the left anterior pararenal space (short arrow). **B** There is a perihepatic collection (arrow). **C** Subcutaneous collection in the right anterior abdominal wall is seen (arrow). **D** A collection is seen in the rectovesical pouch (arrow)



Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences software (IBM SPSS, version 21, IBM Corp., Armonk, NY). Quantitative data such as age, MCTSI, size of the collection, LOH, and length of ICU stay were expressed as mean with range. The categorical variables were expressed as proportions and percentages. The quantitative variables were compared using Student's *t* test or Mann–Whitney *U* test. The categorical variables were compared using the Chi-square test or the Fischer exact test. For all statistical analyses, a *P* value of $< .05$ was considered statistically significant.

Results

A total of 75 consecutive patients with ANP were assessed during the study period. The mean age was 41.8 years. There were 57 males and 18 females. The most common etiology was alcohol abuse ($n = 50$), gallstone disease ($n = 20$), post-endoscopic retrograde cholangiopancreatography ($n = 3$), and idiopathic ($n = 2$). The mean MCTSI was 8.16 (range 4–10). Twenty-five (33.3%) patients had collections at unusual locations. Fifty patients (66.7%) had collections at usual locations. There was no significant difference in the age (42.56 vs. 40.36 years, $P = .478$) and sex distribution (72% vs. 78% males, $P = .566$) between the two groups.

Unusual Sites of Necrotic Collections

Most common among these sites was mesentery ($n = 17$, 68%), followed by splenic subcapsular location ($n = 7$, 28%), omentum ($n = 6$, 24%), and hepatic subcapsular ($n = 4$, 16%) locations. More than one unusual site was involved in 10 patients. These sites are shown in Table 1. Ten patients had acute necrotic collections, and 15 patients had walled-off necrosis. In addition to the collection at unusual sites, peripancreatic collections were present in 14 patients. Collections at multiple sites were present in 19 (76%) patients.

Table 1 Uncommon sites of necrotic collections in 25 patients

Location	Number (%)
Mesentery	17 (68%)
Subcapsular splenic	7 (28%)
Omentum	6 (24%)
Subcapsular hepatic	4 (16%)
Anterior abdominal wall	3 (12%)
Pelvis	2 (8%)
Inguinoscrotal	1 (4%)

Management of Patients with Unusual Sites of Necrotic Collections

Thirteen patients in group I were managed conservatively. Interventions in the form of drainage (PCD and endoscopic drainage) and surgery were performed in 12 (48%) patients. PCD, endoscopic drainage, and surgery were performed in 11, 2, and 2 patients, respectively. One patient underwent PCD and surgery and two patients underwent PCD and endoscopic drainage. Out of the patients managed conservatively, 12 (48%) patients recovered. Two deaths occurred in patients managed without interventions. Among the patients managed with drainage, one death occurred. Similarly, one patient died among the patients who underwent surgery. Overall, four patients died.

Comparison of CT Findings

Mean MCTSI was 7.76 in group I versus 8.36 in group II with no statistically significant difference ($P = .181$). Pancreatic necrosis was detected in 17 (68%) patients in group I compared with 41 (82%) patients in group II. However, the difference was not statistically significant ($P = .172$). There was no significant difference in the degree of pancreatic necrosis between the two groups ($P = .421$). However, group II had 16 (32%) patients with necrosis of the entire pancreas compared with no patients with complete parenchymal necrosis in group I ($P = .001$). There was no significant difference in the sites of parenchymal necrosis between the two groups. The mean size of the collection in group I was 11.66 cm compared with 10.35 cm in group II with no statistically significant difference between the two groups ($P = .162$). There was no significant difference in the density of collection between the two groups (15.5 HU in group I vs. 17.87 HU in group II, $P = .221$). One (4%) patient in group I had an extension of the necrotic collection to paracolic gutter compared with 4 (8%) patients in group II ($P = .659$). Ascites and pleural effusion were present in 16 (64%) and 15 (60%) patients, respectively, in group I and 30 (60%) and 35 (70%) patients in group II, respectively. However, the difference was not statistically significant.

Comparison of Clinical Outcomes Between the Two Groups

Percutaneous catheter drainage was performed in 11 (44%) patients in group I and 21 (42%) patients in group II with no statistically significant difference ($P = .869$). The LOH was 25.48 ± 19.79 days in group I and 29.94 ± 22.74 days in group II with no significant difference ($P = .407$). The ICU stay was 7.8 ± 12.54 days in group I and

5.84 ± 10.33 days in group II ($P = .474$). There was no significant difference in the need for surgery (group I, 8% vs. group II, 12%; $P = .597$) and mortality (group I, 16% vs. group II, 18%; $P = .829$).

Subgroup analysis of patients in group I did not reveal differences in clinical outcomes between patients with collections at multiple sites versus those with collection at single unusual site. The mean LOH was 22.11 days in patients with collections at multiple sites versus 36.17 days in patients with collections at single unusual site ($P = .340$). Similarly, ICU stay (7.21 days vs. 9.67 days, $P = .685$), need for drainage (47.3% vs. 33.3%, $P = .681$), surgery (5.2% vs. 16.6%, $P = .430$), and mortality (15.7% vs. 16.6%, $P = 1$) was not significantly different between patients with collections at multiple sites and those with collection at single unusual site.

Table 2 shows the comparison of CT findings and outcome parameters between the two groups.

Table 2 Comparison of CT findings and clinical outcomes in two groups

Finding	Group I (n=25)	Group II (n=50)	P value
<i>CT findings</i>			
MCTSI	7.76 ± 1.85	8.36 ± 1.79	.181
Pancreatic necrosis	17 (68%)	41 (82%)	.172
Extent of pancreatic necrosis (AP dimension)			
≤50%	2 (8%)	2 (4%)	.421
1–75%	5 (20%)	11 (22%)	
76–100%	10 (40%)	28 (56%)	
Site of pancreatic necrosis			
Head	0	2 (4%)	.751
Body	8 (32%)	7 (14%)	.066
Tail	0	4 (8%)	.294
Multiple sites	9 (36%)	12 (24%)	.460
Entire pancreas	0	16 (32%)	.001
Size of collection	11.66 ± 3.44 cm	10.35 ± 3.97 cm	.162
Density of collection	15.5 ± 5.79 HU	17.87 ± 8.45 HU	.221
Ascites	16 (64%)	30 (60%)	.681
Pleural effusion	15 (60%)	35 (70%)	.411
Extension of collection to paracolic gutter	1 (4%)	4 (8%)	.659
<i>Clinical outcomes</i>			
Percutaneous drainage	11 (44%)	21 (42%)	.869
LOH (days)	25.48 ± 19.79	29.94 ± 22.74	.407
Length of ICU stay	7.8 ± 12.54	5.84 ± 10.33	.474
Surgery	2 (8%)	6 (12%)	.597
Mortality	4 (16%)	9 (18%)	.829

MCTSI Modified CTSI, AP anteroposterior dimension, LOH length of hospitalization, ICU intensive care unit

Discussion

Necrotic collections are one of the most critical local complications of AP [11]. In the present study, we investigated the unusual locations of necrotic collections in AP. We compared the CT findings and clinical outcomes between the patients having collections at unusual locations with those having collections at usual sites in the retroperitoneum. We found that among the unusual sites, small bowel mesentery was most commonly involved. The next most common site was the splenic subcapsular location. We found that all the CT findings and clinical outcomes were comparable between the two groups except the extent of pancreatic necrosis. Although isolated extrapancreatic necrosis, necrosis of the pancreatic head, and multifocal parenchymal necrosis were more common in the group with fluid collections at unusual locations compared with the patients having fluid collections located at usual locations, the difference was not statistically significant. Patients with fluid collections at unusual sites were less likely to have necrosis of the entire pancreas compared with the other group with a statistically significant difference. On subgroup analysis of group I, there were no differences in the clinical outcomes between patients with single versus multiple collections.

Because of the location of the pancreas in retroperitoneum, AP is associated with inflammatory changes and fluid collections in the retroperitoneum [2, 3]. Ishikawa et al. applied the concept of interfascial planes to classify AP based on retroperitoneal extension [12]. They divided the retroperitoneal extension into five grades and found an excellent correlation between CTSI and their classification system. The involvement of mesentery or omentum was not considered for classification. Waele et al. reported a scoring system called extraperitoneal inflammation on CT [13]. This scoring system, besides including the retroperitoneal involvement, also gave scoring to mesenteric involvement. However, the involvement was in the form of inflammation rather than fluid collections. The root of mesentery communicates with the anterior pararenal space and gets involved as a result of the contiguous spread of inflammation [2]. Thus, mesenteric inflammation is commonly encountered in AP. In the study by Mendez et al., 15.6% of the patients showed mesenteric inflammation on CT [14]. However, Chi et al., reported mesenteric involvement on magnetic resonance imaging in 61.9% of the patients [3]. Despite the reports of mesenteric involvement in the form of inflammatory changes, fluid collections in mesentery in the setting of AP have not been described. We found mesenteric collections in 17 (68%) of the patients in the group of patients having collections at unusual sites.

Pseudocysts in spleen and liver have been described in case reports and case series [15–17]. The mechanism

of formation of fluid collections in or around the spleen and liver is the tracking of pancreatic enzyme-rich secretions along anatomical planes. The distal portion of the tail of the pancreas is located in the splenic hilum contained in the splenorenal ligament, providing a pathway for the spread of the enzymatic secretions along the spleen [18]. Similarly, the gastrohepatic ligament pathway is responsible for spread of inflammation and formation of collection along the liver [19]. In a series of 500 patients with chronic pancreatitis, five patients had intrasplenic pseudocysts, and two had an intrasplenic hematoma [15]. In another series of 159 CT studies in 100 patients, splenic subcapsular hemorrhage was reported in two patients [17]. Splenic infarcts and subcapsular hemorrhage have been reported to be more common in AP [17]. The intrahepatic pseudocysts and subcapsular pseudocysts along the liver are less commonly reported [19]. In a recent review of literature by Demeusy et al., 54 cases of intrahepatic pseudocysts in 44 publications were reported [20]. We also found the subcapsular collections along spleen to be more common than the collections along the liver. We, however, found no published cases reporting the occurrence of necrotic collections at these sites, but we believe that the same mechanisms could explain these collections as well.

The accumulation of fluid in the extraperitoneal space of the abdomen is rare [10]. It manifests as swelling of the anterior abdominal wall. Necrotic collections in the pelvic cavity are also rarely encountered. Similarly, inguinoscrotal involvement in AP is rare [6–8]. The fluid can track along the retroperitoneum, deep and superficial rings and lead to an extension of collections in inguinoscrotal location. In the present study, we found the collections in the anterior abdominal wall in three patients, pelvic collections in two patients, and inguinoscrotal collection in one patient.

The clinical significance of these unusual sites of necrotic collections is due to the challenges in management [21, 22]. While the subcapsular collections in spleen and liver may be managed successfully with PCD, the anterior abdominal wall collections are notorious for causing pancreatocutaneous fistula and concomitant morbidity [16]. The deeper mesenteric, omental, pelvic, and inguinoscrotal collections are difficult to drain via percutaneous or endoscopic approaches and may mandate surgery. Due to the rarity, there are no guidelines for the management of collections at these sites.

There were a few limitations to our study. The number of patients having collections in the abdominal wall, pelvis, and inguinoscrotal location was small. However, because these sites are very rarely involved, our study still gives an insight into the relative involvement of these locations. Additionally, no other published study has systemically analyzed the necrotic collections at unusual sites. The small sample size may have led to a lack of association between the location of collections and clinical outcomes. Finally, we did not

evaluate the role of fat distribution on the site of collections. Studies have shown that fat volume and distribution have an association with clinical outcomes, but the association with unusual locations has not been explored [23]. Follow-up CT scans to document the complete resolution of collection were not available. However, it may not be necessary to perform CT scans on follow-up in all the patients considering the risk of cumulative radiation exposure [24].

In conclusion, the mesentery is a relatively frequent site of necrotic fluid collection in ANP. Omentum, liver, and spleen (subcapsular location), anterior abdominal wall, pelvis, and inguinoscrotal region represent unusual sites for necrotic pancreatic collections.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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