

Wall maturation in necrotic collections in acute pancreatitis: a computed tomography based evaluation

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Abstract

Aim: To systematically investigate the timing of encapsulation of necrotic collections in acute necrotizing pancreatitis (ANP) using contrast-enhanced computed tomography (CECT).

Methods: This retrospective study comprised consecutive patients of ANP who underwent CECT of the abdomen between the second and fourth weeks of illness. Number and site of collections and presence and completeness of the wall (defined as a thin smooth enhancing rim more than 1 mm in thickness) were documented.

Results: A total of 195 patients of ANP were included. Seven hundred seventy-three collections were evaluated in 284 CECT scans. The most common site of the collection was anterior pararenal space (n=290, 37.5%). The mean maximum dimension of the collection was 8.1 cm (range, 3.1-16 cm). Two hundred twenty-two (28.7%) collections had a complete wall. The mean interval to complete wall maturation was 18 days (range, 8-28). Overall, 13.3%, 37.1%, and 56.2% of the collections showed complete encapsulation in the second, third, and fourth weeks, respectively.

Conclusions: Our study suggests that a significant proportion of necrotic collections show complete encapsulation within 4 weeks of the onset of ANP. (*Acta gastroenterol. belg.*, 2022, 85, 463-467).

Keywords: Acute necrotizing pancreatitis, acute necrotic collection, walled off necrosis, encapsulation, multidetector computed tomography.

Introduction

Acute necrotizing pancreatitis (ANP) is a potentially serious condition which can cause marked systemic inflammatory response, organ failure, and local complications including pancreatic and peripancreatic collections. According to the 2012 revision of the Atlanta classification (RAC), acute pancreatitis is classified into interstitial edematous (IEP) and necrotizing forms (1,2). The major contribution of the RAC was the categorization of fluid collections. Collections due to IEP were called acute peripancreatic fluid collections (APFC) and pseudocysts. The transition between two collections was arbitrarily determined to be 4 weeks and defined by a thin enhancing wall on CECT (1). The same time frame was used for necrotizing pancreatitis. Collections in this setting were called acute necrotic collections (ANC, <4 weeks) and walled off necrosis (WON, >4 weeks). This 4-week threshold has therapeutic implications.

Encapsulation is considered a prerequisite for endoscopic drainage and current guidelines advocate endoscopic drainage after 4 weeks (3-5). In clinical practice, early drainage is sometimes indicated and waiting for 4 weeks may result in deterioration of patients' condition (6). Recent studies suggest that encapsulation may occur

earlier than 4 weeks in some patients (7,8). However, there is extremely limited data on the timing of wall maturation on imaging (9). In this study, we investigate the timing of encapsulation of ANC in the first month of illness using CECT scans.

Methods

This retrospective study was approved by the local ethics committee and the need for an informed written consent was waived. Consecutive patients of ANP who were admitted in the gastroenterology unit and underwent CECT scans in the second to fourth weeks from the first onset of pain were included. The indications of CT scan in the second to fourth week of illness were non-resolving organ failure and suspicion of local complications requiring intervention (persistent fever, gastrointestinal hemorrhage, intra-abdominal hypertension, abdominal distension).

Exclusion criteria

Patients who had non-contrast CT scans, those in whom drainage was performed prior to the CT, those who had recurrent acute pancreatitis or acute on chronic pancreatitis were excluded.

Clinical evaluation

Etiology of ANP was documented. Severity of ANP was assessed based on RAC. Moderately severe ANP was defined as the presence of transient (<48 hours) organ failure, local complications, or exacerbation of co-morbid condition. Severe ANP was defined as the presence of persistent (>48 hours) organ failure. Diagnosis of infected necrosis was based on presence of gas within the collection at CT or microbiological evidence of infection within the fluid obtained after drainage.

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CT scan acquisition

CT scans were performed on multidetector row CT scanners (Siemens Somatom Definition Flash, Philips Brilliance iCT, Somatom Definition AS) after intravenous injection of 80-100 ml of non-ionic iodinated contrast agent (iohexol, Omnipaque™ 300 mg/mL iodine) injected at a rate of 3 ml/sec. Scan was acquired from domes to diaphragm to pubic symphysis in the portal venous phase (65-70 sec). Arterial phase using bolus tracking technique was acquired in patients with suspected gastrointestinal bleed, however only portal venous phase was used for assessment of collections. The scan parameters were tube current-300 mAs; voltage-100-120kVp; pitch-0.993; field of view-350 mm and slice thickness-1 mm. Two radiologists (with 8 years and 3 years of experience in abdominal imaging) blinded to the indication and timing of the scan and the intervention performed, evaluated the CT scans in consensus. The scans were evaluated for the presence of collections. The site and maximum dimension of collection was recorded (10). Collections were considered multiple if they extended to more than one space and counted accordingly. The wall of a collection was defined as a thin smooth enhancing rim. Multiplanar coronal and sagittal reconstructions were evaluated to document the completeness of wall formation. Collections that appeared ill-defined with no discernible wall were categorized as having “no wall”. Collections with enhancing wall surrounding more than 80% of the necrotic fluid were categorized as having “complete wall”, and rest of the collections were categorized as having “incomplete wall” (8). CT severity index (CTSI) was calculated (11).

All the CT scans were divided into intervals (second, third and fourth week) from the first onset of pain by a gastroenterologist not involved in reading of the scans. Few patients underwent multiple CT scans in the 1st 4 weeks. In these patients, the subsequent CT scan was assessed if a complete wall was not demonstrated on the initial CT. The completeness of wall was recorded according to the interval from the pain onset.

Statistical analysis

The data was entered in Microsoft excel. The continuous data was presented as mean with range. The categorical data was presented as proportions and percentages. The association of encapsulation with the site of collection was tested using Chi-square test or Fisher exact test. The results were considered statistically significant if $p < 0.05$.

Results

Patient characteristics

A total of 195 patients (135 males, mean age 39.4 years) were enrolled. Eighty-four patients underwent 1st

Table 1. — Characteristics of the included subjects

Parameters	Results
Mean age (years)	39.4 (range, 14-74)
Sex (Male: Female)	2.25 (135:60)
Etiology of pancreatitis	
• Alcohol	89 (45.6%)
• Gallstones	70 (35.9%)
• Post-ERCP	6 (3.1%)
• Idiopathic/not known	28 (14.4%)
Severity of AP	
• Moderately severe	69 (35.4%)
• Severe	126 (64.6%)
Infected collection*	79 (40.5%)
• Lesser sac	19
• Paracolic gutter	25
• Pararenal space	31
• Others	4
Mean CTSI score	8.9 (range, 3-10)

AP: acute pancreatitis; CTSI: computed tomography severity index. * Presence of gas or microbiological evidence of infection

Table 2. — Wall maturation based on the interval from pain onset and site of collection

Interval from onset of pain	Number of collections
2nd week	449
Complete wall	60 (13.3%)
Incomplete/no wall	389 (86.7%)
3rd week	105
Complete wall	39 (37.1%)
Incomplete/no wall	66 (62.9%)
4th week	219
Complete wall	123 (56.2%)
Incomplete/no wall	96 (43.8%)

follow-up CT, and five patients underwent a 2nd follow-up CT within 4 weeks. Baseline characteristics of the included patients are enlisted in Table 1. Most common etiology of ANP was alcohol (45.6%), followed by gallstone disease (35.9%). Moderately severe and severe disease was present in 35.4% and 64.6% of the patients, respectively. Seventy-nine (40.5%) patients had infected necrosis.

CT findings

Mean CTSI was 8.9 (range, 3-10). The mean maximum dimension of collection was 8.1 cm (range, 3.1-16 cm). Gas within the collection was present in 61 (12.4%) collections. Seventy-three (37.4%) patients had ascites.

Wall characteristics on CT scans

A total of 773 collections were evaluated on 284 CECT scans. The details of site and number of collections are

Table 3. — Wall maturation on the serial CT scans based on the site of collections

Interval from onset of pain	APS	LS	PCG	MS	OS
2nd week					
All collections	176	59	150	56	8
Complete wall (%)	25 (14.2)	8 (15.6)	19 (12.6)	7 (12.5)	1 (12.5)
Incomplete/no wall	151	51	131	49	7
3rd week					
All collections	41	10	38	12	4
Complete wall (%)	18 (43.9)	5 (50)	9 (23.6)	5 (41.6)	2 (50)
Incomplete/no wall	23	5	29	7	2
4th week					
All collections	73	33	66	28	19
Complete wall (%)	52 (71.2)	18 (54.5)	29 (43.9)	15 (53.5)	9 (47.3)
Incomplete/no wall	21	15	37	13	10

APS: anterior pararenal space, LS: lesser sac, PCG: paracolic gutter, MS: mesenteric OS: other sites.

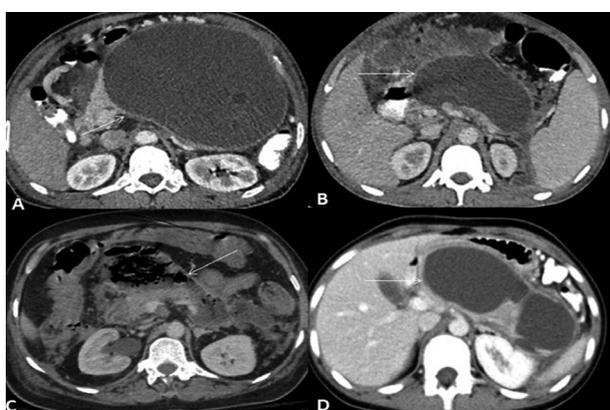


Figure 1. — Axial CECT of different patients demonstrating peripancreatic collections in the anterior para-renal space and lesser sac with complete enhancing wall (arrows) at varying durations [A, second week (Day 13); B, third week (Day 15); C, third week (Day 20); D, fourth week (Day 22)].

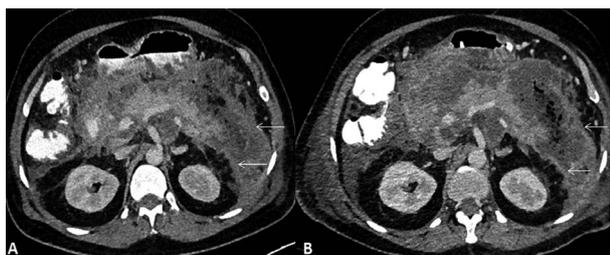


Figure 2. — Axial CECT of a 40-year-old male with alcohol related acute necrotizing pancreatitis on day 4 demonstrating peripancreatic collections with no definite enhancing wall (arrows, A). Enhancing peripheral wall is identified in the third week (day 19) of illness (arrows, B).

shown in Table 2, 3 and Figures 1-3. Wall maturation according to the interval from pain onset and site is shown in Table 3. Overall, 13.3% (60/449), 37.1% (39/105), and 56.2% (123/219) of the collections showed complete encapsulation in the second, third, and fourth week, respectively. A significantly greater number of pararenal space collections showed complete encapsulation in the fourth week as compared to collections at other sites



Figure 3. — Axial CECT of a 31-year-old female with gallstone related acute necrotizing pancreatitis on day 12 demonstrating peripancreatic collections with no definite enhancing wall (A). Complete enhancing peripheral wall is identified in the third week (day 21) of illness (arrows, B).

(71.2% vs. 43.9-54.5%, $p=0.022$). Fewer paracolic gutter collections showed complete encapsulation in the third week compared with the collections at other sites, however, the difference was not statistically significant ($p=0.303$).

Evaluation of encapsulation in patients with multiple CT scans in first 4 weeks

Eighty-four patients underwent two CT scans, and five patients underwent three CT scan in the 1st month of illness. Between 1st and 2nd week, the number of completely encapsulated collections increased from 6.4% (3/47 collections on 1st week CT scan) to 29.1% (16/55 collections on 2nd week CT scan). Between 2nd and 3rd week, the number of completely encapsulated collections increased from 14.8% (8/54 collections on 2nd week CT scan) to 34.4% (21/61 collections on 3rd week CT scan). Finally, between 3rd and 4th weeks, the number of completely encapsulated collections increased from 38.9% (7/18 collections on 3rd week scan) to 61.1% (11/18 collections on 4th week scan) (Figure 4).

Discussion

The clinical course of ANP varies greatly from mild to moderate disease to severe illness requiring

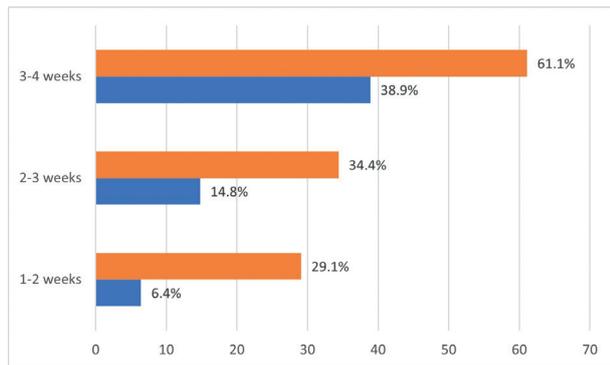


Figure 4. — Bar diagrams showing encapsulation rates in patients undergoing serial CT scans. Blue bar and orange bar show percentage of completely encapsulated collections in the initial and later week of the each range, respectively.

prolonged hospital stay, ICU admissions, and nutritional support (12). Fluid collections represent important local complication of ANP. Although most sterile fluid collections are self-limiting and tend to eventually resolve, those which get secondarily infected or cause gastrointestinal or biliary compressive symptoms require drainage (5,13). Minimally invasive drainage procedures have revolutionized the management of pancreatic fluid collections. Both endoscopic transmural drainage (with or without necrosectomy) and percutaneous drainage are considered preferable to surgery due to significantly reduced morbidity and mortality (14). Endoscopic drainage is recommended after 4 weeks to ensure encapsulation of collection. However, the 4 weeks threshold for wall maturation is arbitrary and is based on the RAC consensus.

In the present CT-based study, we observed that more than one-third of the necrotic collections had complete wall in the third week. In the fourth week, more than 50% of the collections had complete wall. Grinsven et al. categorized collections based on the degree of encapsulation on CT as moderately (less than 50%), largely (between 50 and 99%), or fully (100%) encapsulated (9). They reported complete encapsulation (WON) in 3, 12, and 29% of the patients in 2nd, 3rd, and 4th week, respectively. Clinically relevant (largely or fully encapsulated) WON was reported in 43% of the patients in the 1st 3 weeks. Two previous interventional studies also evaluated the time of wall maturation in ANP (7, 8). Trikudanathan et al. evaluated 193 patients who required endoscopic interventions for degree of encapsulation of collections. They described collections as having no wall, some wall, extensive wall, and complete wall but did not explicitly define these based on CT. They reported extensive and complete wall in 48.6% (36/76) and 6.8% (5/76), and 35.4% (40/117) and 42.5% (48/117) of the patients before and after 28 days, respectively (7). Oblizajek et al. reported complete wall in 42.1% (8/19) of the patients on CT in the first month (8). The complete wall was defined explicitly as enhancing rim around more than 80% of the collection. These results suggest

that arbitrary 4-week threshold for defining WON may be inaccurate. Imaging based classification of collections rather than 4 weeks should be used for classifying necrotic collections into ANC and WON.

Our study had several limitations. It was a retrospective study and hence there was no defined protocol for acquisition of CT scans. However, the acquisition of CT scans in our study mirrors the clinical practice. Though the aim of our study was to investigate encapsulation in the first 4 weeks, it would have been interesting to see the proportion of collections encapsulating beyond 4 weeks (e.g., at 6 weeks). Many patients without a complete wall (in the 2nd or 3rd weeks) did not have follow up CT scans. However, routine follow up CT scans are not advisable due to the risk of cumulative radiation exposure (15). Finally, the impact of determining wall encapsulation within 4 weeks for therapeutic purpose is not evaluated in our study.

In conclusion, a significant proportion of ANCs show complete encapsulation within 4 weeks. The definition of ANC and WON should be based on imaging demonstration of wall rather than RAC criteria.

Conflict of Interest

All the authors have no conflict of interest.

Financial disclosure

None

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