Abdominal imaging PICTORIAL ESSAY

Necrotizing pancreatitis with fat necrosis: The radiologist's point of view

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ABSTRACT

Learning Objectives: This pictorial review highlights the pathology and clinical features of fat necrotizing pancreatitis, focusing on its classification and imaging findings through recent case analysis.

Background: Pancreatitis is an inflammatory condition with complex pathology. In necrotizing pancreatitis, both pancreatic and peripancreatic tissues are affected, leading to high morbidity. Fat necrosis, a serious complication, involves saponification of peripancreatic fat. Early imaging (CT or MRI) is crucial for diagnosing fat necrosis, especially when clinical improvement is lacking. Late-stage imaging helps identify complications and guide follow-up.

Findings: We analyzed 10 cases of necrotizing pancreatitis from December 2021 to March 2024. CT scans, performed with a 320-detector row, 640-slice scanner, revealed key features of fat necrosis: linear stranding, hyperattenuation, heterogeneous peripancreatic fat, and encapsulated collections. In two cases, complications such as peripancreatic abscesses required CT-guided drainage.

Conclusion: Pancreatitis with fat necrosis presents significant diagnostic and management challenges. Early identification of the pathology through imaging and timely medical or surgical intervention can prevent severe complications.

KEY WORDS

Pancreatitis, necrotizing, fat necrosis, imaging

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Introduction

Pancreatitis is a complex inflammatory condition of the pancreas that often triggers a multifaceted pathological response, affecting both the pancreas itself and surrounding tissues. The revised Atlanta classification system categorizes acute pancreatitis into two primary forms: interstitial edematous pancreatitis (IEP) and necrotizing pancreatitis (NP) [1]. Necrotizing pancreatitis is further divided into three subtypes based on the affected areas: parenchymal necrosis, peripancreatic necrosis, and the combined type, with the combined form being the most common presentation.

In cases of necrotizing pancreatitis, both the pancreatic tissue and peripancreatic structures can be involved, leading to significant complications. This condition is associated with a high rate of morbidity and mortality, making early detection and accurate diagnosis critical for effective management. [1]

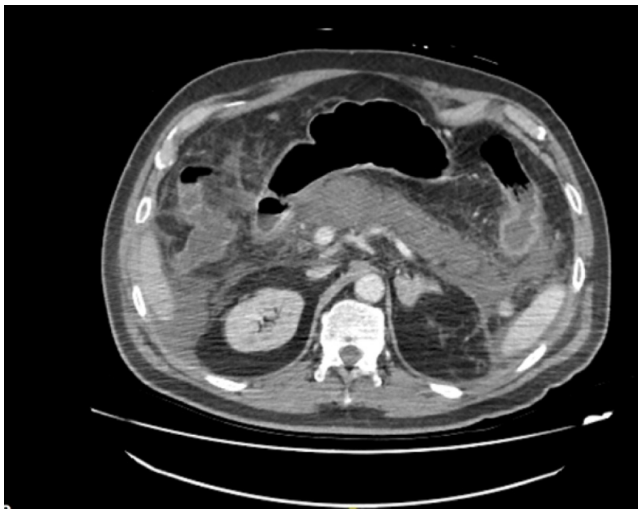

Figure 1 *Hypoattenuating pancreatic parenchyma and peripancreatic fluid collections indicating necrotizing pancreatitis*

Pathophysiology of Fat Necrosis in Necrotizing Pancreatitis

Fat necrosis in necrotizing pancreatitis results from a cascade of inflammatory and enzymatic processes initiated by the damage to the pancreas. The pathophysiology involves several key steps:

1. **Pancreatic Enzyme Release**: During necrotizing pancreatitis, the acinar cells of the pancreas are damaged, leading to the release of digestive enzymes, particularly lipases, into the surrounding pancreatic and peripancreatic tissues. Under normal conditions, these enzymes are secreted into the digestive tract to aid in fat digestion. However, when released into tissues, they begin to digest the fat cells present in and around the pancreas [1,2]
2. **Fat Saponification**: The released lipase enzymes hydrolyze triglycerides in adipose tissue, breaking them down into free fatty acids and glycerol. These free fatty acids then react with calcium ions present in the tissue, forming insoluble calcium salts in a process known as saponification. [1,3].
3. **Inflammatory Response**: The presence of necrotic tissue and saponified fat triggers a robust inflammatory response. The body recognizes the damaged tissue as foreign, leading to the recruitment of immune cells such as neutrophils and macrophages to the site. These immune cells release cytokintes and other inflammatory mediators, which exacerbate the local inflammation and contribute to further tissue damage [4] .
4. **Tissue Destruction and Abscess Formation**: As the inflammation progresses, the necrotic and saponified fat may become surrounded by a fibrous capsule, leading to the formation of a pseudocyst or abscess. This can result in the collection of pus or other fluids within the affected area, further complicating the clinical picture. The necrotic tissue itself can also become infected, leading to additional systemic complications [3,5].

The resulting fat necrosis can have significant clinical implications, contributing to the severity of necrotizing pancreatitis. It can lead to persistent pain, systemic inflammation, and sepsis if secondary infection occurs. Additionally, the calcified fat deposits can be visualized on imaging studies, providing crucial diagnostic information. [3,6]

Identifying the imaging findings and overcoming the diagnostic challenges associated with pancreatitis-related fat necrosis is essential for effective patient care. During the early stages of the disease, if a patient's clinical condition fails to improve or worsens, imaging techniques such as computed tomography (CT) or magnetic resonance imaging (MRI) become crucial for diagnosing fat necrosis. In the later stages, imaging continues to play a vital role in diagnosing complications, monitoring disease progression, assessing treatment response, and guiding patient management. [7]

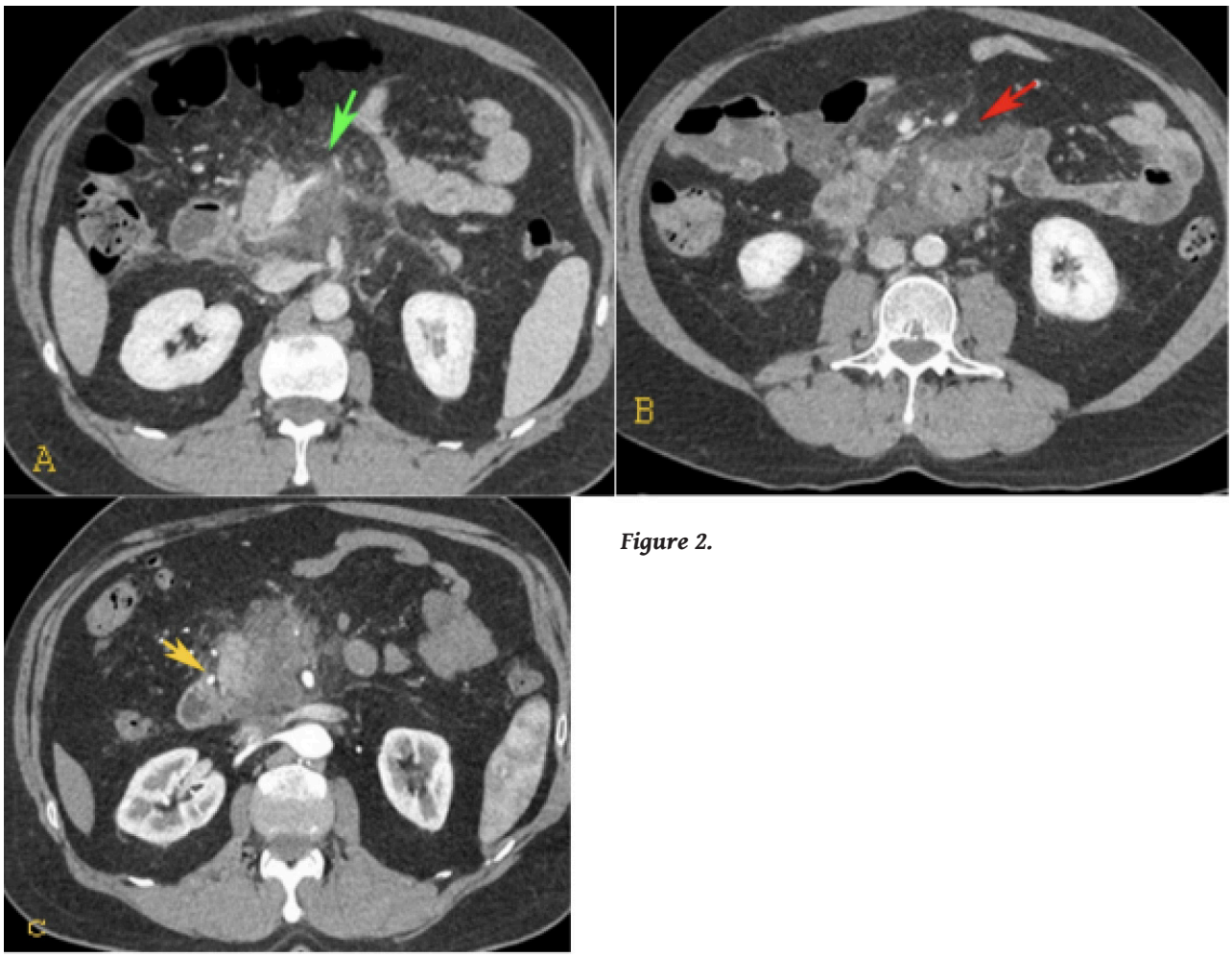

Figure 2.

Imaging in Necrotizing Pancreatitis

CT is the primary imaging method for evaluating the morphologic features of necrotizing pancreatitis. It can be used 72h after presentation of the disease to exclude necrosis. An attenuation of pancreatic tissue less than 30HU in pancreatic phase suggests necrosis. The severity is determined by the grading (<30%, 30%-50%, >50%) of pancreatic disease extension. Increased fat attenuation with heterogeneous appearance, linear stranding, and encapsulated fluid suggest peripancreatic necrosis.

MRI is an alternative imaging modality that can be used in young patients, in pregnancy or in cases with an allergy to iodinated contrast agent. MRI might be able to better specify recommendation of fluid collections. [7,8]

Imaging findings

Scanning was performed with a 320 detector row, 640-slice CT scanner.

Intravenous contrast was administered in all cases some with pancreatic protocol (40 seconds post- injection of a non-ionic iodinated contrast with a rate of 4ml/s) and others obtained in portal phase depending on the original clinical question (60 seconds post- injection of a non-ionic iodinated contrast with a lower rate).

All the presented cases were diagnosed with necrotizing pancreatitis with complication of fat necrosis and almost all their clinical outcome was poor.

The main CT radiological features that suggest fat necrosis as a complication of necrotizing pancreatitis are:

- Linear stranding,
- hyperattenuation and/or heterogeneous peripancreatic fat,
- encapsulated collections.

[figure 2]

Case 1: 45 y.o. female with abdominal pain, fever, vomiting and anorexia

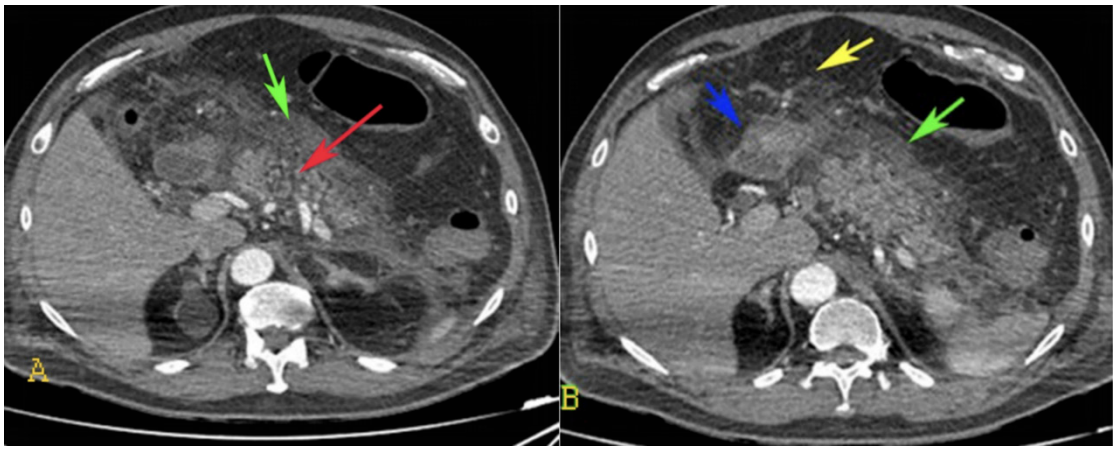

Figure 3.

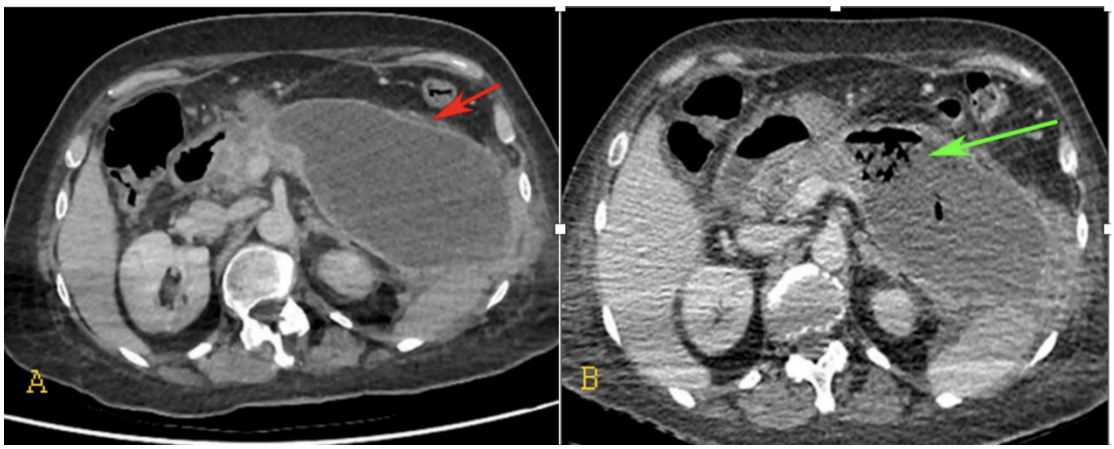

Figure 4.

Axial plane contrast enhanced CT in portal phase (first and second image) and pancreatic phase (third image)

Imaging findings:

A. Fat stranding (green arrow)

B. Peripancreatic hypoattenuating collections (red arrow)

C. duodenal edema (yellow arrow)

[figure 3]

Case 2: 60 y.o. male presented in the Emergency Department with severe abdominal pain and breathlessness.

Axial plane contrast enhanced CT with pancreatic protocol

Imaging findings:

A. Fat stranding (yellow arrow)

B. Pancreatic edema with hypoattenuating areas in the pancreatic parenchyma suggesting necrosis (red arrow)

C. Peripancreatic hypoattenuating collections (green arrow)

D. Peripancreatic and mesenteric enlarged lymph nodes

E. Duodenum edema (blue arrow)

[figure 4]

Case 3: 59 y.o. female with history of acute pancreatitis two months prior, presents with abdominal pain, bloating and severe anorexia

Axial plane contrast enhanced CT in portal phase.

Imaging findings:

A. large pancreatic pseudocyst following acute pancreatitis that lead to necrotizing pancreatitis (red arrow).

B. In the second image, three days after the first scan there is gas inside the pseudocyst indicating infection (green arrow).

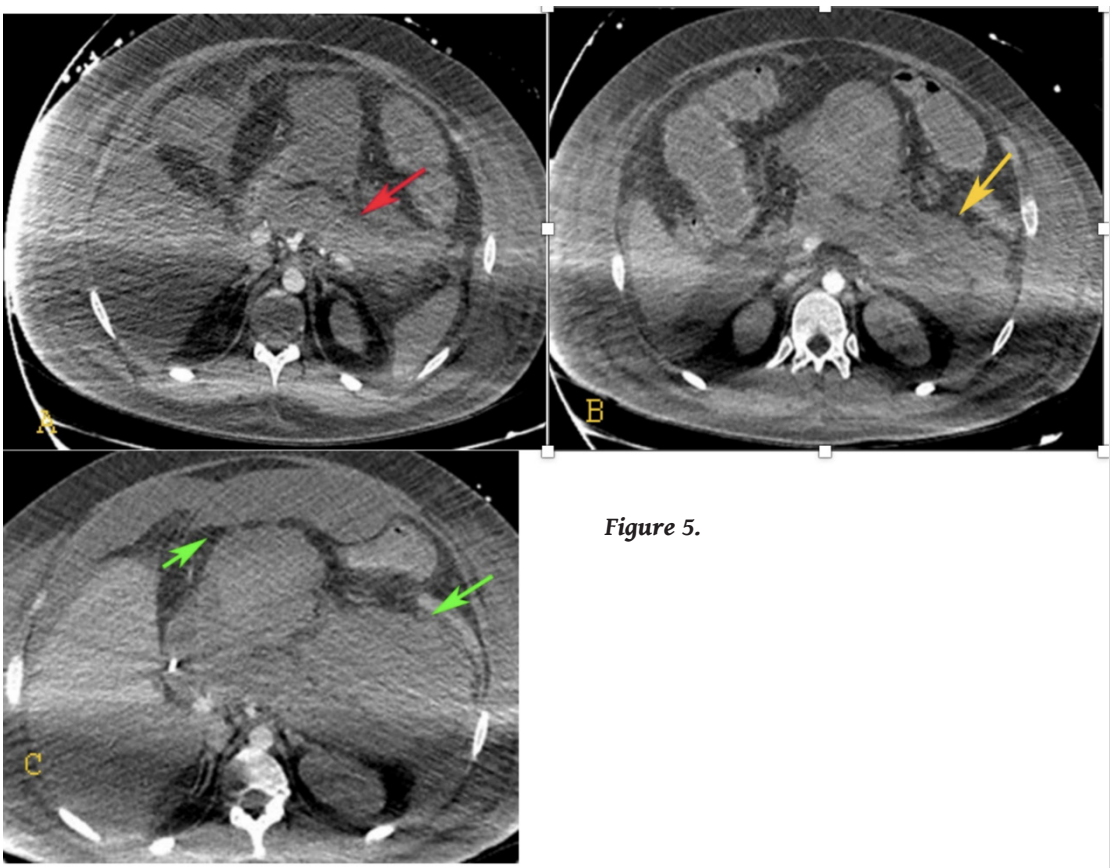

Figure 5.

[figure 5]

Case 4: 23 y.o. obese male with a history of acute pancreatitis five years prior, presents to the emergency department with severe abdominal pain and poor clinical condition

Axial plane contrast enhanced CT in pancreatic phase (first and second image) and portal phase (third image)

Imaging findings:

A. Heterogenity and disorganization of the pancreatic parenchyma with hypoattenuating areas suggesting necrosis (red arrow).

B. Diffuse fluid collections (yellow arrow).

C. Encapsulated fluid collections.

D. Fat stranding

[figure 6]

Case 5: 57 y.o. male in septic condition

Axial plane contrast enhanced CT in portal phase

Imaging findings:

A. Complete disorganization of the pancreatic parenchyma (red arrow)

B. Hypoattenuating fluid collections (green arrow)

C. Heterogeneity in areas of fluid indicating necrosis (blue arrow)

D. Granular imaging of the mesenteric fat (Saponification of fat) (yellow arrow)

[figure 7]

Case 6: 72 y.o. female with abdominal pain and poor clinical condition

Axial plane contrast enhanced CT in portal phase

Imaging findings:

First image:

A. Hypoattenuating areas in the pancreas indicating necrosis (yellow arrow)

B. Fat stranding (green arrow)

C. Fluid collections (red arrow)

Second image (one week later)

A. Encapsulated heterogeneous collection in the pancreatic parenchyma (red arrow)

B. Enlargement and edema of the pancreatic tail (blue arrow)

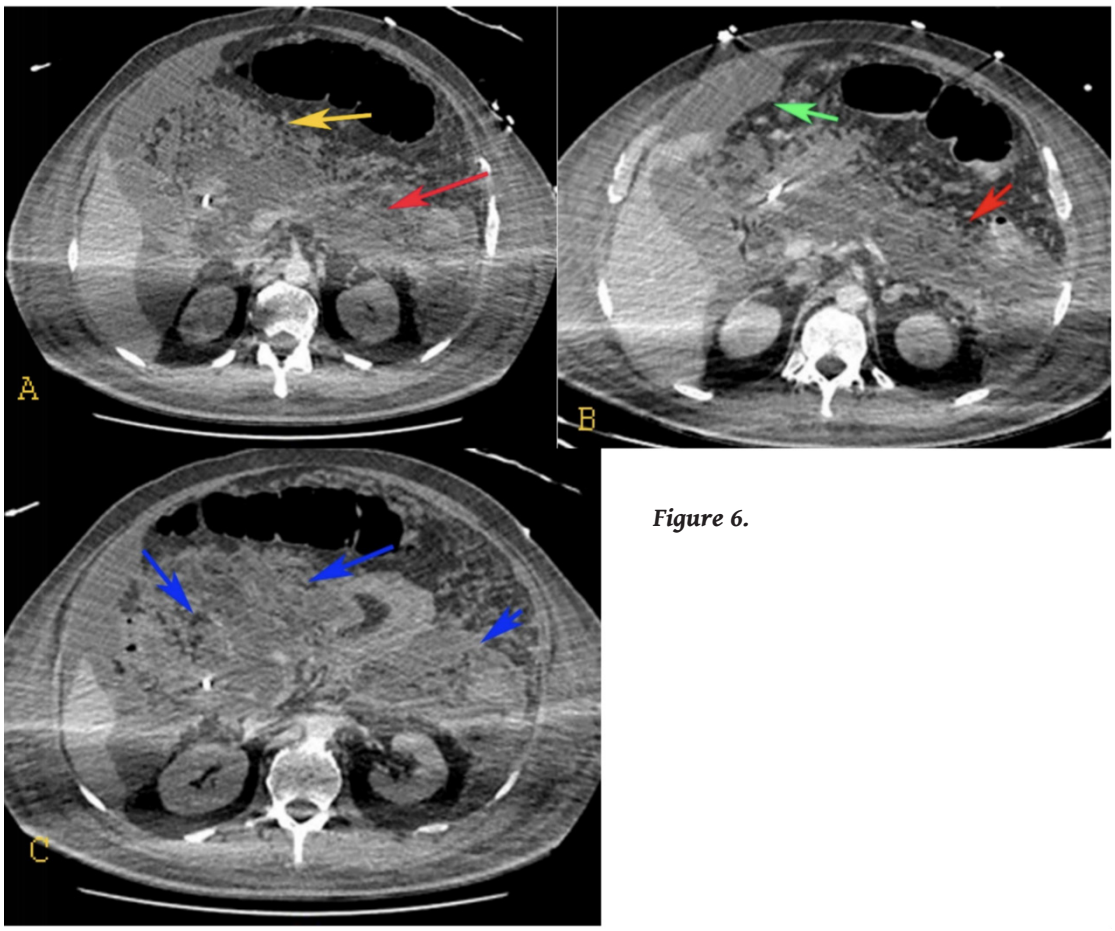

Figure 6.

C. Fat stranding (green arrow)
D. Peripancreatic lymph nodes

[figure 8]
Case 7: 48 y.o. female in septic condition
Axial plane contrast enhanced CT in arterial phase
Imaging findings:
A. Complete disorganization of the pancreatic parenchyma (yellow arrow)
B. Large hypoattenuating fluid collections (blue arrow)
C. Heterogeneity in areas of fluid indicating necrosis (green arrow)
D. Granular imaging of the mesenteric fat (Saponification of fat) (red arrow)

[figure 9]
Case 8: 70 y.o. female with severe abdominal pain and anorexia
Axial plane contrast enhanced CT in portal phase
Imaging findings:
A. Disorganization of the pancreatic parenchyma with hypoattenuating areas indicating necrosis (red arrow)
B. Large heterogeneous encapsulated collection with areas of high attenuation suggesting hemorrhagic collection (blue arrow)
C. Heterogeneity in areas of fluid collections (green arrow)
D. Linear stranding (yellow arrow)
E. Peripancreatic and mesenteric lymph nodes

[figure 10]
Case 9: 64 y.o. male one month after complicated pancreatitis
Axial plane contrast enhanced CT in portal phase (first image)
Imaging findings:
A. Large hypoattenuating encapsulated collection in the tail of the pancreas after necrotizing pancreatitis

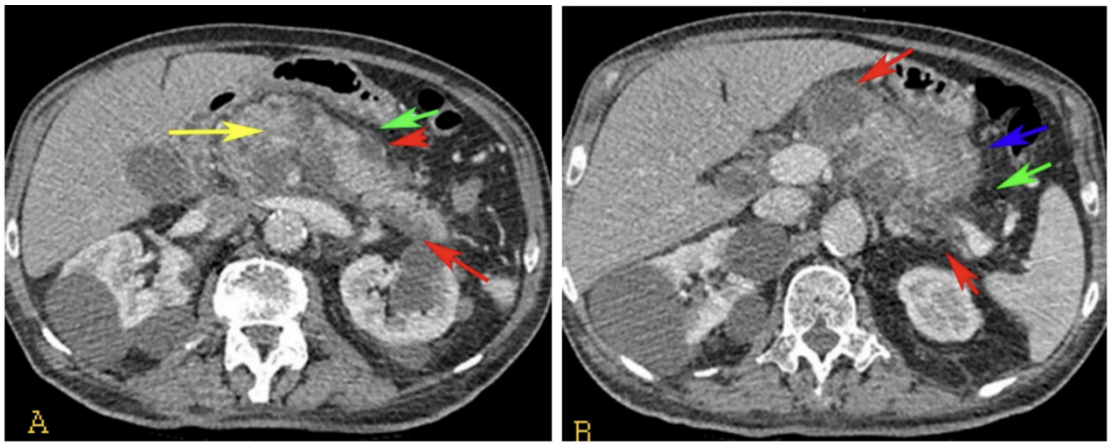

Figure 7.

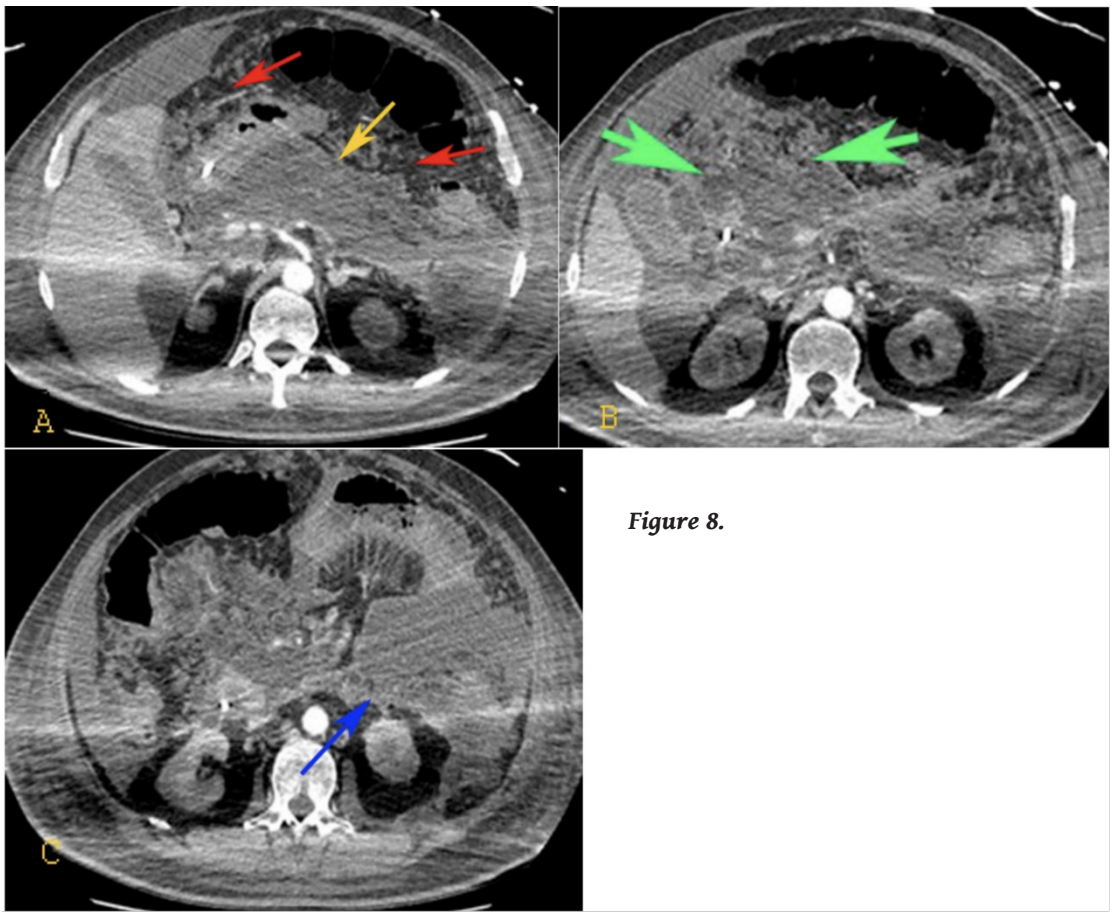

Figure 8.

(yellow arrow).

B. The encapsulated collection was treated with a pig-tail CT guided drainage (red arrows)

[figure 11]

Case 10: 66 y.o. female in septic condition

Axial plane contrast enhanced CT in pancreatic (imag-

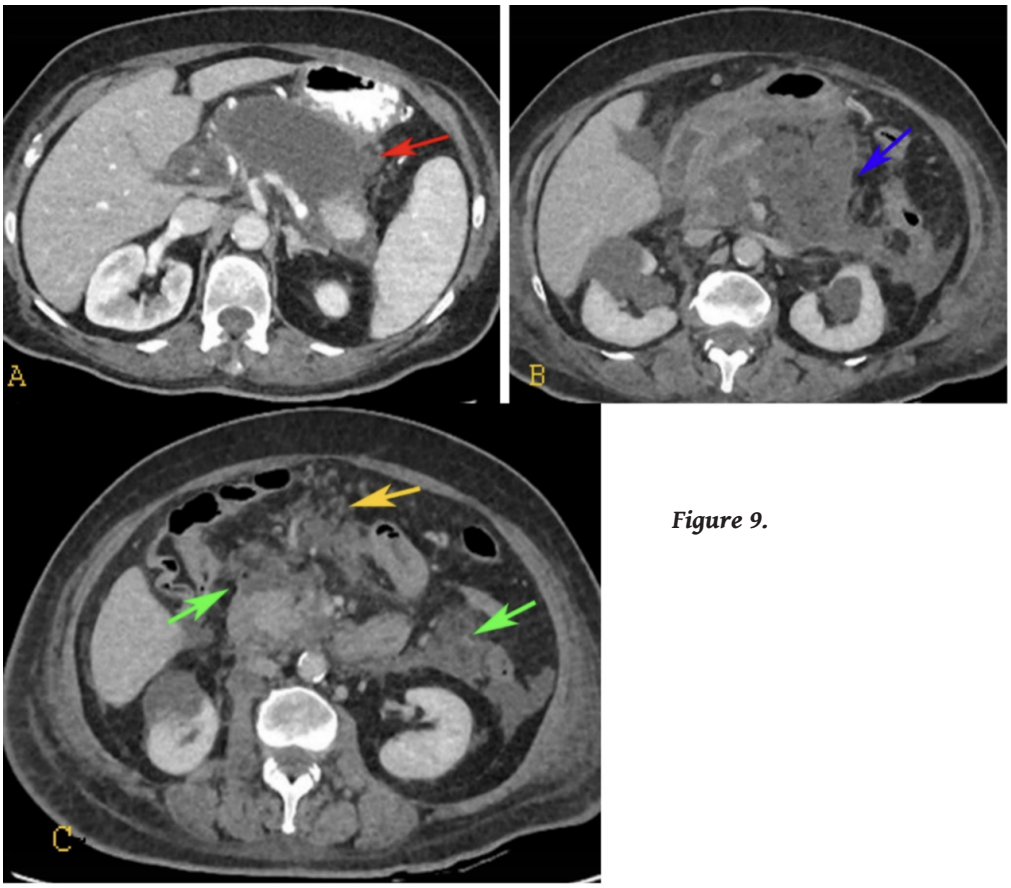

Figure 9.

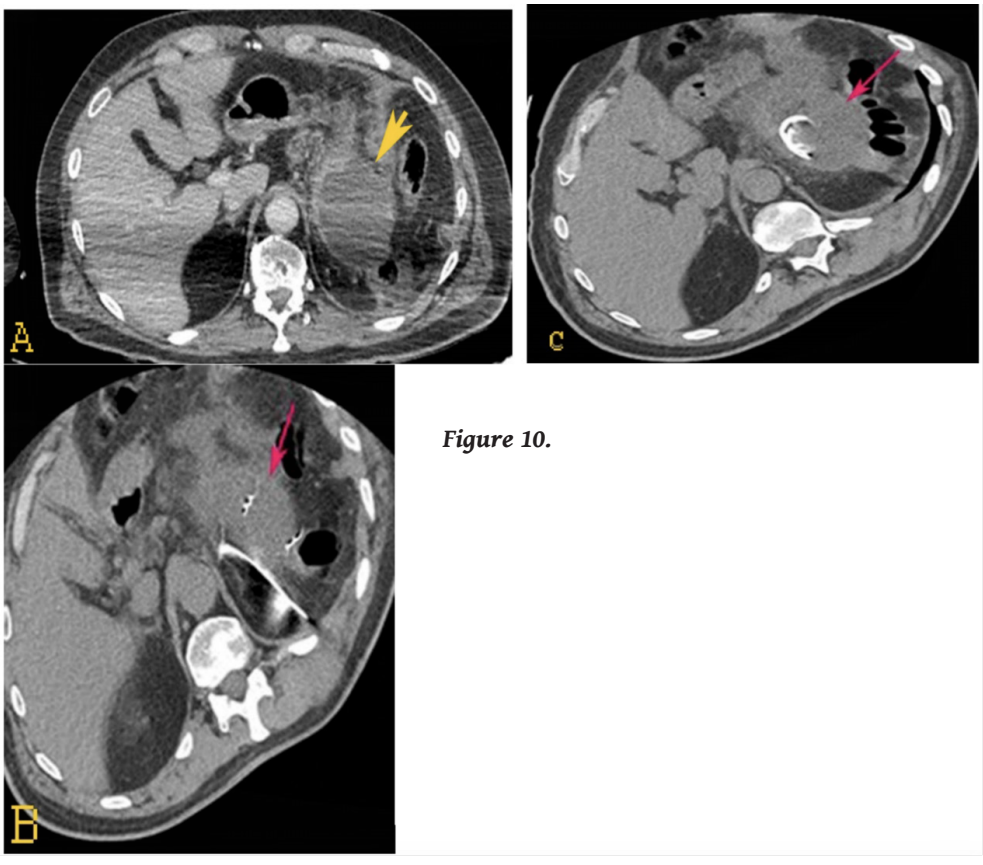

Figure 10.

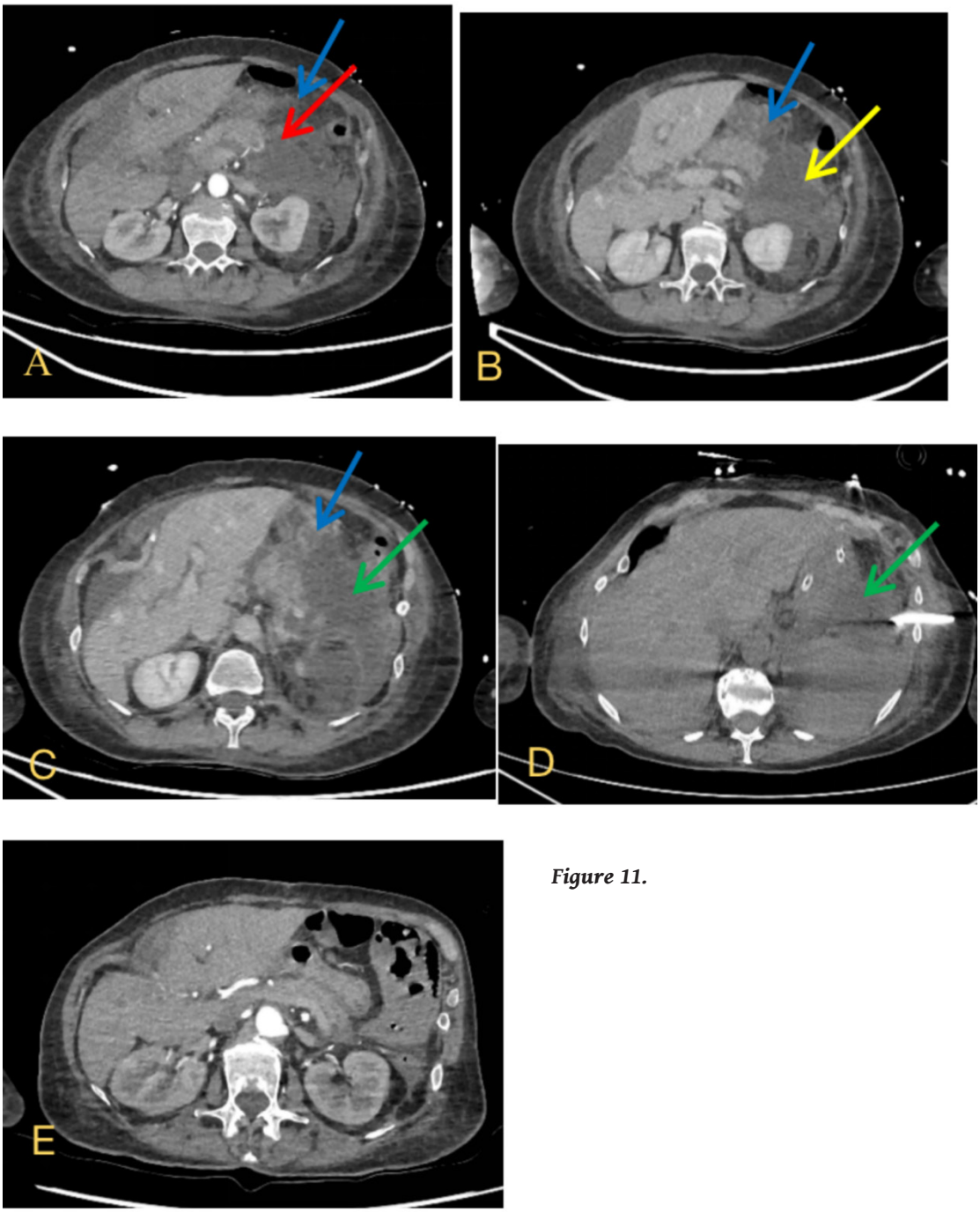

Figure 11.

es A and E), in portal phase (images B and C) and in late phase during CT guided intervention (image D).

Images A and B:

A. Hypoattenuating areas in the pancreas indicating necrosis (red arrow)

B. Fat stranding (blue arrows)

C. Fluid collections (red arrow)

Images C and D (8 days later):

D. Encapsulated heterogeneous collection near the damaged pancreatic parenchyma (green arrow) that was treated by CT guided drainage (Image D)

E. Fat stranding (blue arrow)

Image E:

Follow up of the patient 3 months post CT guided

drainage shows important improvement of the imaging findings with big reduction of the encapsulated and free fluid collections as well as recovery of the pancreatic parenchyma.

Role of Interventional Radiology

Interventional radiology plays a crucial role in the management of necrotizing pancreatitis, particularly in addressing complications such as infected necrosis, abscesses, and fluid collections. Using minimally invasive techniques, interventional radiologists can perform image-guided procedures, such as percutaneous drainage, which can be life-saving for patients with severe complications resulting from necrotizing pancreatitis. These procedures, typically guided by CT or ultrasound, allow for the precise placement of drainage catheters to remove infected material and reduce inflammation, offering an alternative to more invasive surgical approaches. [9]

Conclusion

In summary, fat necrosis in necrotizing pancreatitis is primarily driven by the uncontrolled release of pancreatic lipase, leading to the breakdown of fat, inflammatory response, and tissue destruction. This process contributes to the high morbidity and complexity of necrotizing pancreatitis, requiring careful management and intervention. The early recognition of the pathology with imaging and prompt medical or even surgical treatment can prevent fatal complications. Moreover, with the advancing field of interventional radiology, a less invasive option is provided and helps reduce recovery times, lower the risk of complications, and improve outcomes in patients with necrotizing pancreatitis. **R**

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