

# CT imaging of acute necrotizing pancreatitis

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## Abstract

Computerised tomography (CT) is considered the imaging modality of choice for diagnosis of acute necrotizing pancreatitis (ANP) [1-14]. This is due to its ability to provide high resolution images of anatomical structures including areas of necrosis within the pancreas, as well as involvement of peri-pancreatic structures which often is a complication of ANP. CT protocols for initial pancreatic imaging should at all times include a contrast enhanced study or a dynamic study of the pancreas in order to detect areas of non-enhancement within the pancreas as well as to depict abscess formation or other related complications, such as suppuration or ascites. ANP does not enhance following contrast media administration.

**Keywords:** *Necrosis, contrast enhanced, peri-pancreatic, mortality*

- peri-pancreatic tissues are well seen,
- vascular involvement is easily identifiable [5].

CT has been shown to be very accurate in grading the severity of ANP because it has the ability to detect the most frequent and important complications which include gland necrosis, pancreatic abscess, fluid collection, vascular, gastro-intestinal or biliary tract involvement [3]. Dynamic contrast enhanced CT provides the best means of accurately visualizing the pancreas and diagnosing ANP and its local complications [6]. Noncontrast enhanced imaging of the pancreas cannot exclude pancreatic necrosis [3].

The main accepted indication for dynamic CT in severe ANP is to detect life threatening local complications and to plan invasive interventions within two to three weeks post-admission, allowing early intervention [7]. The role of magnetic resonance imaging of the pancreas is still under evaluation [8].

A CT severity index grading system of APN was recently developed. The system combines the two CT prognostic indicators which determine outcome, namely extent of necrosis and grade of peri-pancreatic inflammation. The extent of the pancreatitis is graded from A to E: A indicates a normal pancreas and E represents a pancreas where two or more fluid collections, or the presence of gas in, or adjacent to, the pancreas, are visible. This system is thought to have an excellent correlation between CT necrosis and developments of complications and death [6].

CT's ability to clearly demonstrate the anatomy and pathology of abdominal structures as well as the relation to surrounding structures, makes it an ideal imaging modality of the pancreas. The retro-peritoneal fat surrounding the pancreas in most patients affords good CT delineation of the organ even in the presence of dilated bowel loops [9]. Irregular fibrosis of the pancreas and residual healed acute pancreatitis, which shows as calcification, are visible on CT images [1].

## Role of contrast media in CT imaging of the pancreas

Contrast media for abdominal CT imaging are used to enhance blood vessels and vascular organs, for example, the liver and spleen, as well as pathological structures such as tumours, abscesses and inflammatory structures/organs. Inflammatory processes have a higher vasculature therefore display a higher than usual uptake of contrast media thus a higher attenuation of contrast media compared to normal structures [10].

A normal pancreas enhances after intravenous contrast medium administration depicting an

homogenous granular pattern of the internal structure of the organ. Pancreatic enhancement is further improved due to opacification of larger vessels surrounding it compared to un-enhanced fluid within the pancreatic ducts [10]. Contrast enhanced CT has proved to be of primary importance in both the diagnosis and grading of ANP and should be performed as a first line investigation since no other diagnostic imaging modality has such a decisive and sensitive characteristic [9].

For optimal imaging of the pancreas a dynamic scan can be performed at a desired bed position where visualization of perfusion patterns of the pancreatic parenchyma is possible. This aids in staging the severity of the pancreatitis as well as detecting secondary changes. Due to potential aspiration in the event of surgery oral contrast is not recommended for use in CT imaging of patients with suspected ANP [9].

## Etiology of acute necrotizing pancreatitis

In Western countries over 80% of acute necrotising pancreatitis cases are associated with excessive alcohol abuse or the presence of biliary calculi which damage the pancreatic excretory ducts leading to ANP [11]. Figures 1 and 2 are abdominal CT images of a patient who consumed 5 liters of alcohol on the day prior to his admission.

Other causes of ANP include mumps, glandular fever, abdominal trauma, surgery, complications secondary to endoscopic retrograde cholangio-pancreatography, hypercalcemia, hyperparathyroidism, hyperlipidemia, certain drugs and polyarteritis [5]. In 25% of all cases the cause of acute necrotising pancreatitis is idiopathic [10].



**Figure 1:** *Unenhanced CT demonstrating an enlarged pancreas extending to the anterior abdominal cavity (black arrows).*

## Introduction

Computerised tomography (CT) is a fast sensitive imaging modality for the detection of abdominal pathologies. CT is used extensively in imaging of pancreatic pathologies and has in the past been indispensable in imaging of acute necrotizing pancreatitis (ANP). ANP can be defined as an inflammatory disease of the exocrine pancreas which results from injury to the acinar (zymogenic-enzyme producing) cells [1]. If the disease is severe it often leads to necrosis of the pancreas, hence the term acute necrotizing pancreatitis.

ANP is a common disease with a potentially lethal outcome resulting in a relatively high rate of mortality [2]. CT has the ability to accurately detect the severity of ANP and associated complications such as gland necrosis or pancreatic abscesses [3]. A major advantage of CT is its ability to detect the severity and extent of APN in terms of involvement of surrounding organs and/or structures. This article discusses the etiology and pathogenesis of APN, the role of CT and CT patterns of the disease.

## Role of CT in imaging of the pancreas

CT is the preferred imaging modality over ultrasound because of its overall accuracy [4]. If a patient presents with rapidly deteriorating clinical conditions CT is useful in assessing the development and/or progress of complications [5]. Compared to ultrasound imaging CT has the following advantages, namely,

- dilated bowel does not impede on image quality,



**Figure 2: Contrast enhanced image taken after 100ml of contrast media administration. No pancreatic enhancement is visible confirming acute necrotizing pancreatitis.**

## Pathogenesis

Microscopically the parenchymal network, acinar cells and pancreatic ductal system appear damaged and there is necrosis of the peri-lobular fat. Areas of necrosis are often multi-focal, rarely involve the whole gland, and, may be confined to the periphery with preservation of the core [6]. Necrosis causes release of digestive enzymes into the pancreas parenchyma. These enzymes further damage the parenchymal cells and blood vessels by a process called autodigestion. Necrotic blood vessels, especially veins, are prone to thrombosis, causing ischaemic damage to areas of the pancreas, initiating a vicious cycle of more release of enzyme release which leads to extensive coagulative necrosis of lobules, intervening ducts and blood vessels [11]. This has a snowball effect by causing internal breakdown of pancreatic tissue. Necrosis develops early in the course of severe ANP; it is usually well established approximately 96 hours post onset of clinical symptoms [12].

One in four patients with APN has organ dysfunction. Other complications include hypoxia, hypotension and renal insufficiency [2]. Multiple organ failure is often a syndrome pertinent to ANP. This is a progressive but potentially reversible condition involving two or more systems remote from the original insult. Bacterial contamination of necrosis is deemed to be a serious event which occurs in 40 to 70% of patients and is associated with an increased mortality [13].

## CT appearance of acute necrotizing pancreatitis

Features of ANP include:

- Excessive swelling of the pancreas.
- Ascites might be present in variable amounts.
- Infection from necrosis or exudates may lead to complications.
- Exudate fluid which may permeate into the retro-peritoneal space can become encapsulated [10].
- Pancreatic oedema which may be focal or diffuse.

- Pancreatic necrosis and haemorrhage within the pancreas and surrounding tissue [5].

The severity of the clinical picture is determined by the extent of the necrosis which can cover the greatly enlarged organ like a mantle. Pancreatic necrosis will show an area of low, or absent, enhancement on rapid bolus contrast enhanced CT [10]. In a study done by Balthazar *et al* [14] two clinical features are identified as the main prognostic indicators of the severity of ANP, namely:

- Pancreatic necrosis,
- Peri-pancreatic inflammatory collections.

In other words if these two conditions are visible on CT images the extent of the disease is classified as severe, which is often associated with a poor outcome.

## Prognosis

Necrosis of the pancreatic head has a poor outcome compared to necrosis of the entire pancreas. Patients with necrosis in only the distal portion of the gland usually have a favorable outcome with few complications [6]. The mortality rate of ANP is reported to be between 27 to 45% and is often determined by the extent of pancreatic necrosis and degree of peri-pancreatic necrosis [6]. This is arguably a high mortality that does not bode well for patients with this disease. Elderly patients have a higher mortality rate because of the high frequency of inter-current disease and reduced functional reserve. Mortality amongst persons over 55 years of age is reported to be as high as 11% compared to 2% amongst those patients younger than 55 years. Obese patients are also considered to have a higher mortality risk compared to thin patients [2]. The two phases of mortality recognized in ANP are:

- Death, which may occur early, often within 7 to 10 days after onset of the disease, due to acute shock complicated by renal, respiratory or cardiovascular failure.
- Patients may succumb later in the course of the disease due to local complications of pancreatic necrosis and sepsis [15].

Patients with necrosis are reported to have a mortality rate of 23% and 82% complication rate. There is a zero mortality rate in patients without pancreatic necrosis but a 6% morbidity rate [12]. Treatment of pancreatic necrosis often requires patients to spend long periods in hospital ranging from a maximum of 300 days to 68 days or less [2].

## Concluding remarks

ANP may be a fatal disease with a high mortality rate. Other serious potential complications, for example, ascites, local sepsis and or peri-pancreatic suppuration of exudates, could occur as soon as 96 hours after the onset of the disease.

CT with its a high sensitivity and specificity allows for the depiction of pancreatic anatomy, necrosis and/or pancreatic enlargement as well as other complications. Contrast media administration for pancreatic enhancement is pivotal in CT imaging because the diseased pancreas and necrotic areas are distinguishable from normal enhancing pancreatic tissue.

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