Computer tomography evaluation of acute necrotizing pancreatitis and its complications: a pictorial review.

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Learning objectives

To review the characteristic imaging findings of acute necrotizing pancreatitis and to discuss the most frequent complications and their correlations with the prognosis of the patient.
Background

Acute pancreatitis clinically is defined as a disorder that includes both abdominal pain (typically epigastric location and radiation to the back) and serum amylase or lipase level more than three times higher than normal. Acute necrotizing pancreatitis is a severe form of acute pancreatitis that occurs as a complication in 20%-30% of patients. It is characterized by necrosis around and inside the pancreas and it is associated with high rates of morbidity and mortality. The term parenchymal necrosis refers to nonviable pancreatic tissues and it typically develops early in the disease course and is generally established in 48-72 hours after disease onset. Mortality within the first 2 weeks of onset is most often caused by systemic inflammatory response syndrome, subsequent mortality is common result of uncontrolled infection.

The radiologist plays a key role in the management of such patients, from diagnosis and staging to identification and treatment of complications, as well as in determining the underlying etiology. CT is the primary imaging modality used in the diagnosis and during the follow-up of the patients with acute pancreatitis and it allows to evaluate the evolution of necrotizing pancreatitis and to detect the complications.
Findings and procedure details

CT protocol

CT is performed to confirm the diagnosis of pancreatitis, to confirm the etiology, to assess the presence of pancreatic necrosis or the onset of complications, and finally to give a severity score of the process and a prognosis for the patient. CT should always be performed before and after administration of 1.5-mL/kg contrast iodate agent at a flow rate of 3-3.5 mL/s, with a multi-phasic technique in pancreatic (40 second mean delay after contrast injection) and portal-venous phase (70 seconds). Administration of oral contrast medium is not necessary.

Although CT is the exam of choice in the acute onset of pancreatitis, it can not exclude the presence of necrosis if it is performed in the first 72 hours. CT should be performed not earlier than 3 days after the onset of the symptoms to detect necrosis more accurately.

CT findings and signs

Pancreatic necrosis is diagnosed on CT when all or part of the pancreas does not show enhancement after intravenous contrast administration. Peripancreatic necrosis can involve the mesenteric fat and other abdominal organs and it can be recognized by the presence of hyperdensity of the peripancreatic fat or fluid collection in the abdomen. Combined pancreatic and peripancreatic necrosis (75%), peripancreatic necrosis alone (20%) or pancreatic necrosis alone (< 5%) can be present in acute pancreatitis.

After 4 weeks fluid collection can evolve in a pseudocyst with non-epithelialized walls and fluid content inside or in a walled-off necrosis that contains necrotic material and involve both pancreatic and peripancreatic tissue. Infection in one of the most frequent complications (20% of cases) and it is suspected when the presence of gas is detected within a fluid collection. On contrast-enhanced CT images, pseudocysts can be diagnosed as well-circumscribed, usually round or oval peripancreatic fluid collections of homogeneously low attenuation that are surrounded by a well-defined enhancing wall.

The modified CT severity index (CTSI) can be used to radiologically grade the severity of acute pancreatitis with good prognostic accuracy. Modified CTSI assigns points on the basis of the presence and extent of pancreatic inflammation, parenchymal necrosis, and extrapancreatic complications. Points are awarded on the basis of the presence of pancreatic enlargement, peripancreatic fat necrosis, collections, the amount of pancreatic necrosis and extrapancreatic complications such as pleural effusion, ascites, vascular
complications, parenchymal complications and/or gastrointestinal involvement. The score correlates with the mortality and indexes of patient morbidity, including occurrence of pancreatic infection, length of hospital stay, and need for invasive intervention.

After four weeks the collection of acute pancreatitis can develop a discrete well-defined, non-epithelialized enhancing wall. Pseudocyst is a sterile organized peripancreatic homogeneous encapsulated fluid collection containing pancreatic secretions, associated with the acute edematous pancreatitis. Walled-off necrosis (WON) contains mixture of necrotic material originating from necrosis both pancreatic and peripancreatic tissues, and it develops when necrotic tissues and acute necrotic collections mature and form a capsule. Approximately 60% of acute fluid collections evolve into sterile WON, 20% are complicated by infection, and the remaining 20% resolve spontaneously. Treatment of WON typically requires surgical or endoscopic necrosectomy.

Complications of acute necrotizing pancreatitis

Complications of acute necrotizing pancreatitis include infections, venous thrombosis of splenic or portal vein, pseudoaneurysms and hemorrhage. Possible complication described in patients with pseudocyst are persistent enlargement, infection, hemorrhage and biliary or gastric obstruction. The collections may displace and compress adjacent organs. In this case obstruction of the stomach or bowel and hydronephrosis are possible complications of the mass effect.

Infection is a major complication of pancreatic necrosis, occurring in 20-30% of cases and is responsible for high mortality among patients with acute necrotizing pancreatitis (25-70% of patients). Infection can occur at any time during the course of the disease but most commonly occurs 2-4 weeks after presentation. At imaging, the presence of bubbles of gas within a collection is considered to be diagnostic of abscess formation. However, when this sign is absent, infection cannot be diagnosed unless percutaneous aspiration is performed.

Severe acute pancreatitis may be also complicated by vascular abnormalities such as pseudoaneurysm formation, reported in 3.5-10% of cases. The most commonly affected arteries are the splenic (40%) and gastroduodenal (30%) arteries. Vascular thrombosis is another frequently observed complication secondary to inflammation or extrinsic compression by the edematous gland or pseudocyst.

Hemorrhage in acute pancreatitis may be caused by enzymatic damage to the surrounding vessels, such as the splenic artery and gastroduodenal artery. Unenhanced CT demonstrates heterogeneous high-attenuation material corresponding to hematoma
and, after administration of contrast agent, the active extravasation of contrast is characteristic of active bleeding.

Finally, pancreatitis-related biliary obstruction can occur as a result of common bile duct strictures or external compression secondary to mass effect and surrounding fibrosis.
Fig. 1: Contrast-enhanced CT of acute necrotizing pancreatitis demonstrates area of low enhancement in the pancreas (*) due to necrosis and hyperdensity of the pancreatic fat due to fat necrosis (arrow).

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**Fig. 2:** CT image in pancreatic phase shows a severe acute pancreatitis with hypodensity of the pancreatic body and tail due to necrosis (*).
Fig. 3: Contrast-enhanced CT in pancreatic phase demonstrates the presence of hypodense area of necrosis in the pancreatic head (arrow) and in peripancreatic fat (*).

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**Fig. 4:** CT image in pancreatic phase demonstrates the presence of hypodense pancreatic necrosis (*) in the pancreas body and non-necrotic pancreatic parenchyma in the tail (arrow).

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Fig. 5: CT in portal-venous phase shows voluminous pseudocyst with mass-effect on the adjacent organs (arrow).

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Fig. 6: Axial contrast-enhanced CT shows presence of fluid and gas bubbles in an infected necrosis in a patient with acute necrotizing pancreatitis (arrow).

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**Fig. 7:** Contrast-enhanced CT in pancreatic phase in a patient with acute necrotizing pancreatitis shows an infected peripancreatic collection with the presence of multiple air bubbles.

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Fig. 8: CT images before (a) and after (b) administration of contrast agent show active intracystic hemorrhage in pancreatic pseudocysts in a patient with acute necrotizing pancreatitis (arrow).

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Conclusion

Complications of necrotizing pancreatitis are common and they are often associated with high morbidity and mortality. Contrast-enhanced CT is the best technique in the evaluation of patient with acute pancreatitis and it can detect a wide variety of complications affecting the pancreatic gland, pancreatic duct, and surrounding vasculature.
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References