CLINICAL IMAGING

Ultrasonography of Acute Pancreatitis – an Essay in Images

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Abstract

Acute pancreatitis is a relatively frequent disorder with an increased risk potential. Ultrasound may represent the first imaging technique to be used in disease evaluation. The diagnosis is usually made based on the increase in pancreas volume and on the changes in structure detected on the ultrasound examination. The most frequent complications are: local and distal collections, parenchyma necrosis, superinfection and vascular involvement.

Key words

Acute pancreatitis - complications - ultrasonography - fluid collections - Doppler ultrasonography

Rezumat

Pancreatita acută este o afecțiune relativ frecventă, cu potențial de severitate crescut. Ecografia constituie prima investigație imagistică utilizată pentru evaluarea severității afecțiunii. Diagnosticul se formulează pe baza creşterii în volum a pancreasului şi modificărilor de ecostructură. Complicațiile sunt: colecții, locale şi la distanță, necroza parenchimului, suprainfecția şi coafectarea vasculară.

Introduction

Acute pancreatitis is a potentially severe inflammatory disease with an unpredictable evolution (1). It is characterised by a "release" of enzymes out of the pancreatic ducts associated with oedema, haemmorhage and necrosis in the parenchyma within the pancreatic region and in the retroperitoneal area. The histological changes may be interstitial, reversible in the mild/moderate acute pancreatitis or global with significant alteration of the pancreas function and structure in severe pancreatitis (approximately 15% of the cases) (1,2).

The incidence of acute pancreatitis does not depend on gender or race and it is very rare in children. In adults, the incidence increases in the case of alcohol consumption and when there are associated dysmetabolic diseases (3). Complications occur in about 25% of all acute pancreatitis cases and global mortality due to this disorder has been high – about 10 – 25% – over the last 20 years (2). There are cases with a single episode of the disease and cases in which relapses occur (4). In approximately 10% of the cases an aetiological factor can be identified (5).

The aetiology of acute pancreatitis is biliary or alcoholic in over 70% of the cases (6). Less frequently, it can be caused by endoscopic procedures (retrograde endoscopic cholangiography), abdominal trauma, surgery with pancreas biopsy or percutaneous puncture. Acute pancreatitis may occur after drug consumption or during pregnancy. In children, the aetiology may be of traumatic, infectious or congenital origin (anomalies of Wirsung's duct, cystic fibrosis, choledocal cysts) (7).

The diagnosis of acute pancreatitis is made clinically (according to severity and complications – severe epigastric pain radiating to the back, profuse sweating, vomiting, intestinal obstruction, shock, fever, etc.), biologically (testing for pancreatic enzymes in the blood/urine and testing for other markers included in risk scores such as Ranson or Apache II) and by means of imaging techniques (8).

Although the CT-scan represents the most efficient method in evaluating patients with acute pancreatitis and although magnetic resonance imaging (MRI) is more and more frequently used for the same reason, ultrasound examinations represent the first imaging diagnostic methods used in patients with suspected acute pancreatitis (4, 9, 10).

Ultrasound examination (US). This method is widely accessible and can be repeated as often as necessary (2). It permits pancreas visualisation in about 75 – 93% of the cases irrespective of the patient's weight or of the extent of intestinal distention due to gas or food content (2, 11). On

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US examination, biliary lithiasis can be identified and other causes of medical or surgical acute abdomen can be excluded (mesenteric ischaemia, perforation in hollow organs, ruptured aortic aneurism, renal colic, acute appendicitis etc.) (2, 12). The well-known disadvantages of US are that images cannot be reproduced and its operative dependent character.

The examination techniques are: external, endocavitary and intraoperative. The external examination is the most frequently used. The main examination is in the "grey scale" US using the transducer with normal or harmonic frequency levels (3.5 – 5 MHz). The investigation consists of obtaining transverse or oblique sections of the epigastric region by mildly changing the transducer angle caudally. The transhepatic approach is used in examining the head of the pancreas; the transplenic approach is used for the examination of the pancreas tail (12). Administration of gaseous water may improve the image by creating an optimal medium of ultrasound transmission. Using this technique, the whole pancreas including the tail part can be visualised.

A normal pancreas has the shape of a "horseshoe" and is located anteriorly as to the vertebral column. It has a homogeneous structure and it is somewhat more echogenic than the neighbouring liver parenchyma. It is well delimited being separated by the peripancreatic fat which has an intensely echogenic appearance. Anteriorly it comes into contact with the stomach whereas posteriorly it comes into contact with the splenic vein, the superior mesenteric artery and the large retroperitoneal vessels (the aorta, the inferior vena cava). The anteroposterior diameter of the pancreas does not exceed 20 – 22 mm. Wirsung's duct – a tubular structure below 2 mm in diameter - can be seen in the middle of the organ (12) (Fig.1).

In characterising the normal pancreas the following should be taken into account: 1. there are no collections or fluid structures in this area; 2. there are no lymph node structures with a distinct ultrasonic appearance; 3. there is no (colour or spectral) Doppler signal at the level of the pancreatic region; 4. there are anatomical variants of the pancreas form, echogenity and size which depend on the patient's weight, status and age (12).

Due to existing technology, the pancreas ultrasound allows for the wide evaluation of the retroperitoneal and even of the whole abdominal region. When carrying out the US examination, the operator should try to obtain information about: anatomy (dimensions, structural pattern of the parenchyma, anatomical relationship to other organs), haemodynamics at the level of the main vessels conveying blood to the pancreas, liver, gall bladder and at the level of the large abdominal vessels. The examination will be combined with invasive diagnostic procedures (mainly, aspiration puncture) and therapeutic ones (ultrasound and/ or x-ray and endoscope-assisted internal or external drainage). The US judgement is anatomoclinical and it should be correlated with the data obtained from the patient's history, from the clinical picture and from the functional and biochemical tests. Other diagnostic imaging techniques will be used if necessary – according to the results of the US examination (12).

The examination protocol of a patient with acute pancreatitis includes:

a. examination of the pancreas region (dimensions, appearance of the parenchyma and of Wirsung's duct, echogenity as to the neighbouring structures);

b. examination of the retroperitoneal area and of the mesenteric structures (blood flow anomalies, collections or oedema areas);

c. examination of recesses and of other areas where enzyme collections are present; study of the large cavities delimited by serous membranes (the peritoneum, the pleurae, the pericardium); description of the collections and evaluation of size;

d. examination of the vessels that might be involved in the disease (portal vascular system, gastroduodenal artery);

e. description of the abdominal parenchymatous and tubular-hollow organs that may influenced or may be involved in acute pancreatitis (liver, cholecyst, bil ducts, spleen, kidneys, digestive tract).

The diagnosis of acute pancreatitis includes*:* the increase in the volume of the pancreas region, structural changes in the parenchyma and significant decrease in echoes. The increase in volume is assessed qualitatively by noting the displacement of abdominal organs (especially the stomach and the transverse colon) and quantitatively by measuring the anteropostrior diameter at the level of the pancreas body. A diameter exceeding 24 mm at this level as well as a marked anterior convexity of the pancreas corresponds to a pathological increase in volume of the gland, a fact that is associated with oedema (Fig.2).

Depending on the amount of hypertrophy, a bulging of the anterior abdominal wall can be noted. The structure of the parenchyma may be homogeneous or non-homogeneous (11). Parenchymal non-homogeneity correlates with areas of oedema and necrosis, which can be zonal or confluent. In incipient oedema the pancreatic echoes are normal. In massive oedema there is marked hypoechogenity of the pancreas region (Fig.3).

The diagnosis of complications in acute pancreatitis includes: identification of peripancreatic collections, areas of necrosis, areas of superinfection, identification of thromboses and pseudoaneurisms in the acute phase and of the pseudocyst and segmentary portal hypertension syndrome in the late phase.

Collections in acute pancreatitis are seen as hypoechogenic or transonic areas. Their delimitation may be indefinite or irregular – in the case of recent collections – or clear in constituted old collections. They may have a peripancreatic location – between the pancreas and the stomach (Fig.4) – or a distal one – in peritoneal recesses (omental bursa, behind the stomach) (Fig.5) or in the large peritoneal cavity (among the intestinal loops and/or at the level of the Douglas' cul-de-sac) (Fig.6).

Associated with enzyme ascites, there is often liquid accumulation in the right or left pleuro-costal sinus (Fig.7).

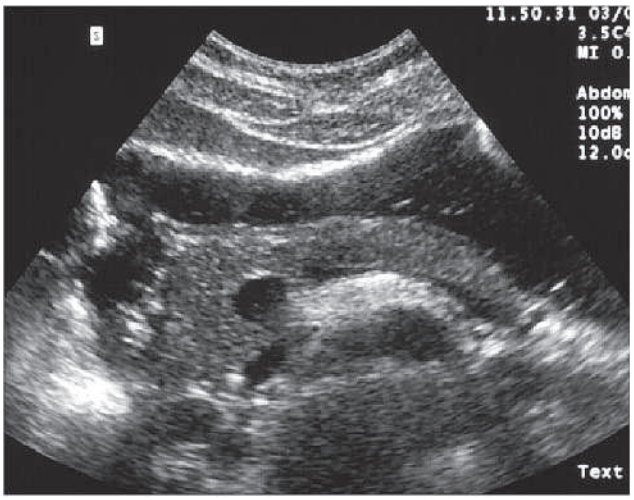

Fig.1 The normal pancreas.

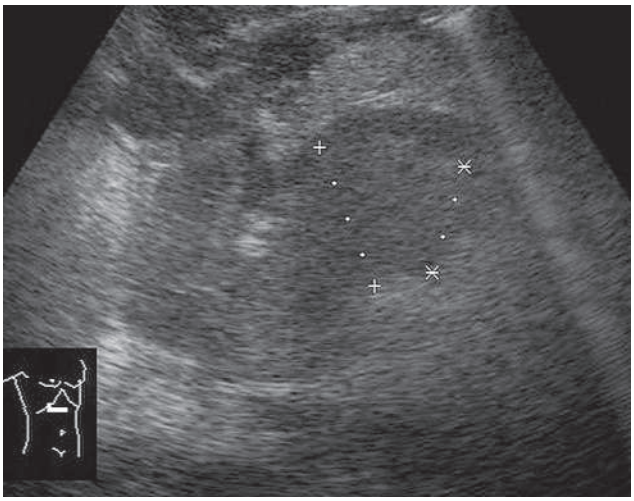

Fig.4 Peripancreatic collection.

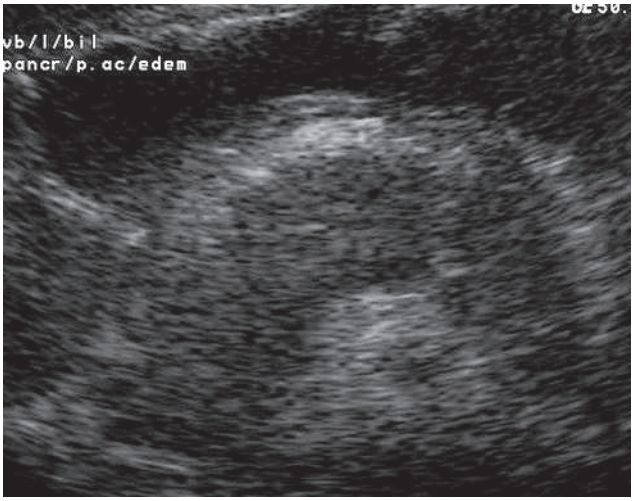

Fig.2 Acute pancreatitis. The pancreas volume is globally increased. The anteroposterior diameter at the level of the pancreas head, body and tail is increased. The stomach is anteriorly displaced.

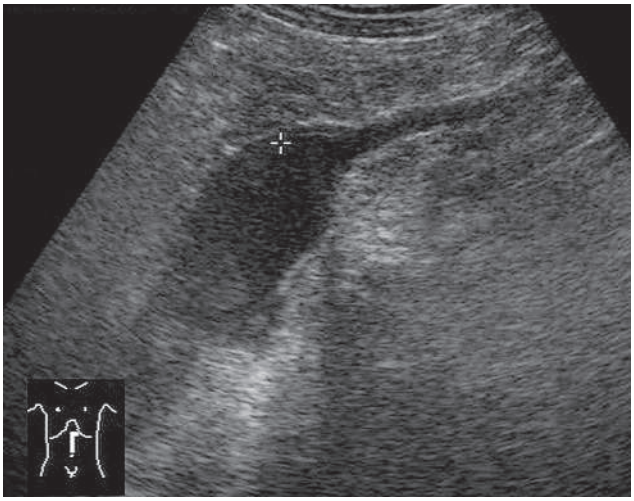

Fig.5 Collection at the level of the omental bursa. The characteristic appearance is that of a prolonged, transonic formation located between the left lobe of the liver and the stomach and reaching to the diaphragm.

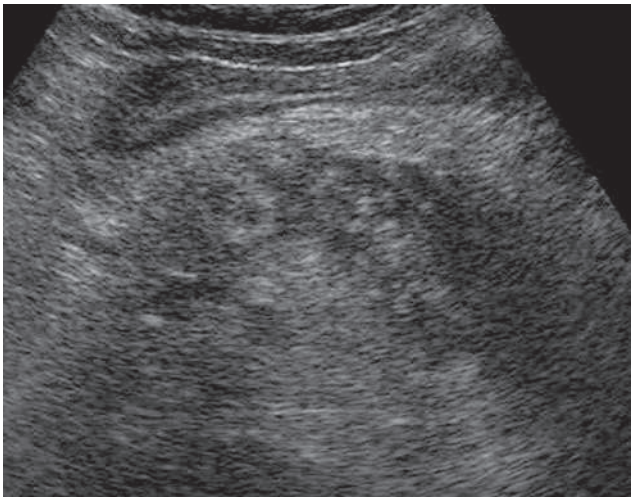

Fig.3 Changes in the parenchyma structure and hypoechogenity corresponding to a pancreatitis with necrotic changes and massive oedema in the pancreas region.

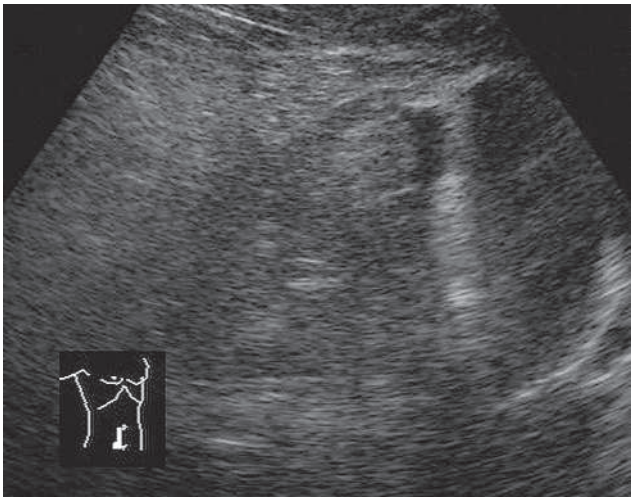

Fig.6 Liquid at the level of the pelvis among the ileal intestinal loops.

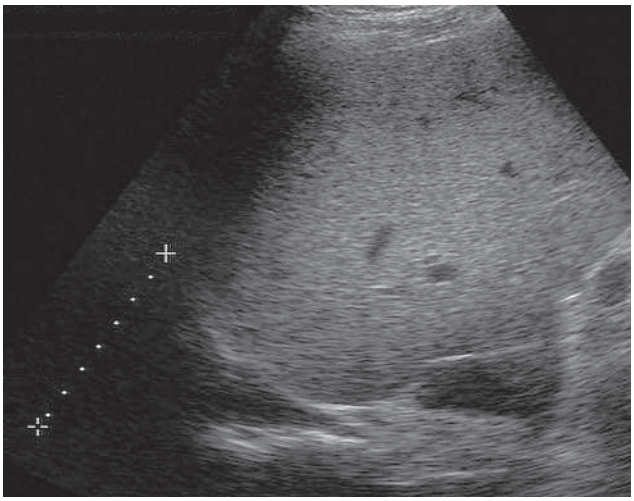

Fig.7 Right pleural collection (markers).

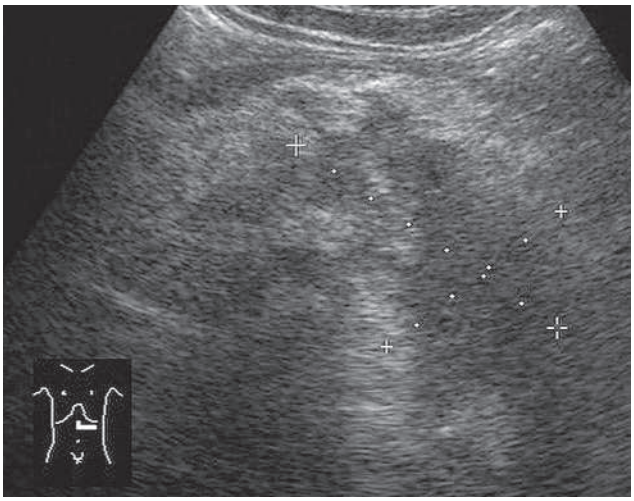

Fig.10 Necrosis of the corporeo-caudal pancreatic parenchyma.

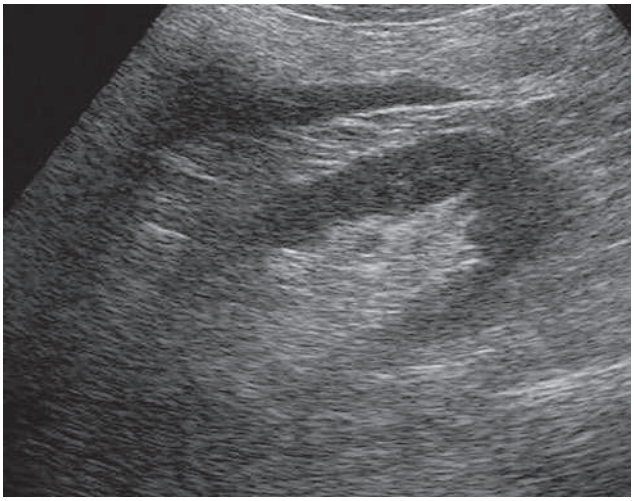

Fig.8 Pancreatic collection located at the level of the left flank along the descending colon.

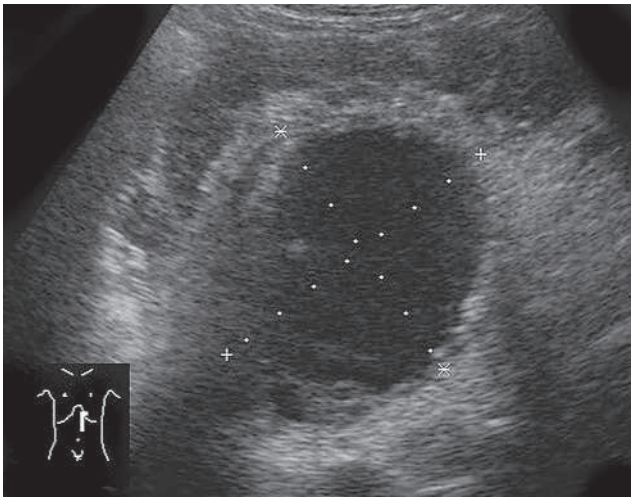

Fig.11 Constituted pancreatic pseudocyst.

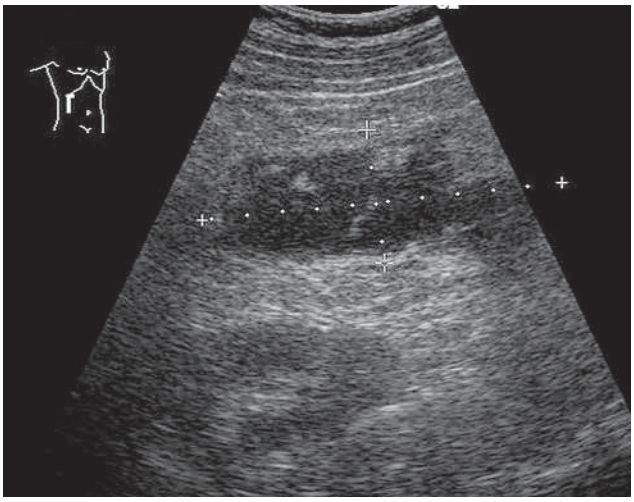

Fig.9 Organised collection with echogenic membranes located under the liver, in the right flank.

Fig.12 Pancreatic abscess at the level of a peripancreatic necrosis area.

Collections can also be identified in the fat composing the mesentery as well as in the fat located in the retroperitoneal space along the colon, at the level of the parietocholic grooves (Fig.8).

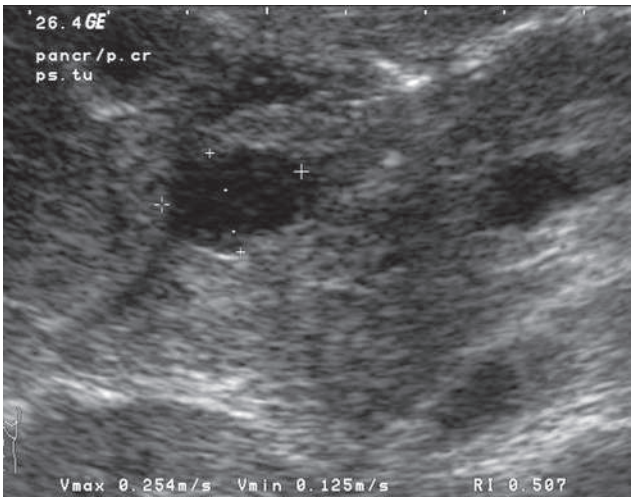

Fig.13 Pseudoaneurysm of the gastroduodenal artery ("grey scale" ultrasonographic appearance).

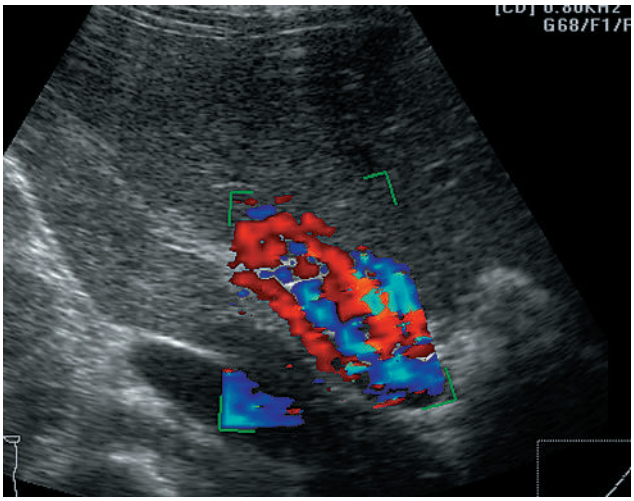

Fig.15 Portal cavernoma occurring after inflammatory thrombosis of the portal vein.

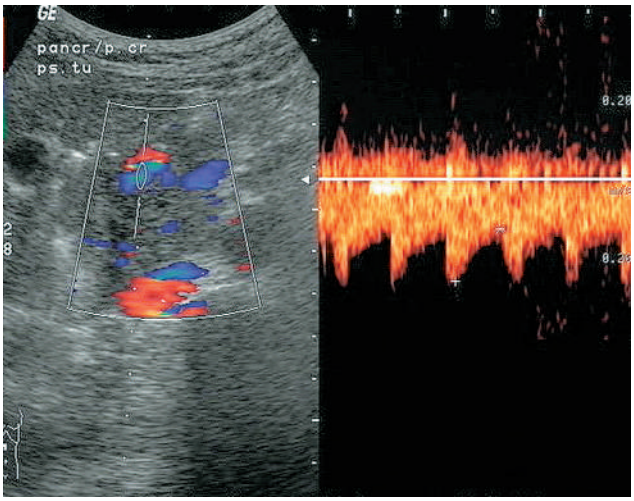

Fig.14 Pseudoaneurysm of the gastroduodenal artery (colour and spectral Doppler appearance).

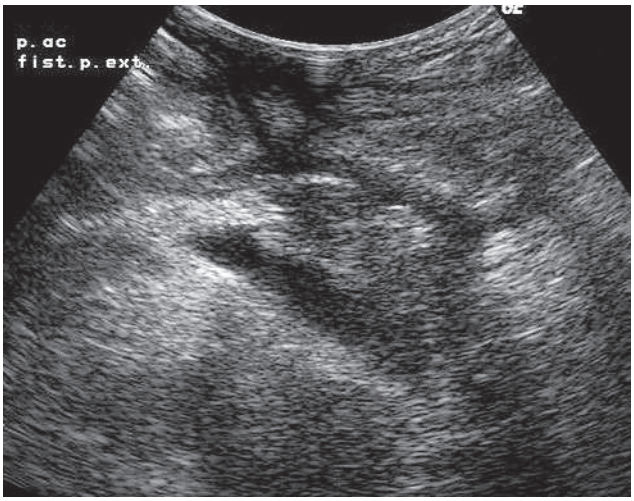

Fig.16 Fistulous route from the pancreas region to the tegument.

The following aspects should be considered:

a. recent collections have a hypoechogenic appearance corresponding to a high level of oedema and, thus, to a resorption potential. The presence of echoes in the form of membranes within these collections may suggest a haematic character (they may be correlated with a rapidly progressing anaemic syndrome) or a fibrinous one (Fig.9). An aspiration puncture is then necessary in order to differentiate between the two entities with different therapeutic options (1);

b. old collections have a transonic appearance and are often well delimited. Their resorption is slow, over weeks or months, and characterised by a tendency of pseudotumoral organisation;

c. the presence of air within a collection may suggest an infection with anaerobic germs. In febrile patients not responding to therapy such as an ultrasound pattern require fine needle puncture with liquid aspiration and cultivation on culture media;

d. in acute pancreatitis several collections may occur at the same time in different stages of evolution. They sometimes communicate through fistulous routes, which cannot be identified by US. More than four collections located in different parts of the abdomen and/or in the pleurae represent a rate of superinfection of over 50% (1,5);

e. in the initial stages of the disease there may be oedema areas with a false-positive appearance of collections or even collections which are reversible over a few hours or days.

Areas of necrosis. It is not possible to detect the moment when necrosis occurs by means of US because the method does not permit the evaluation of microcirculation disorders. However, parenchymal necrosis may be suspected when there is an area of hypoechogenity in the pancreatic region associated with capsule deformation (Fig.10).

An area with no Doppler signal can sometimes be detected within a diffuse exacerbation of blood flow at the level of the pancreatic region. Necrosis is certain when the US appearance is the same for over seven days and if the structural change increases.

The constituted necrosis will be delimited after about 4-6 weeks in the form of a pseudocyst - which occurs in 2-7 %

of all acute pancreatites (1). The pancreatic pseudocyst represents a space replacing structure having 2 mm-thick walls and a transonic content (Fig.11). The presence of echoes inside it is equivalent with sequestra resulting from the parenchymal necrosis

Areas of superinfection cannot be directly identified because they do not have a characteristic appearance. The only suggestive change is the presence of air within a collection – which is rarely detected. The suspicion of infected collection should be raised clinically, relating to the presence of a septic syndrome not responding to therapy. In such a case it can be considered that the infection corresponds to a collection with indefinite delimitation and a very non-homogeneous content. Another element of alarm is represented by changes in the ultrasonographic character. In order to make a clear diagnosis it is necessary to perform an aspiration puncture with cultivation on culture media (Fig.12).

This approach is very important in patients with multiple abdominal and peritoneal collections out of which only one might have a septic content.

Vascular complications. These may complicate the evolution of acute pancreatitis. The pseudoaneurysm of the gastroduodenal artery is characterised by a hypoechogenic or transonic area at the level of the pancreas head; it is clearly delimited, it has a pulsating character, inside haematic clouds looking like a whirl and intense colour Doppler signal. The appearance is similar to that of a smaller size pancreatic pseudocyst (Figs.13,14).

The spectral exploration reveals the arterial character of the blood flow at this level.

Portal and splenic thromboses occur in 10 – 15% of the severe cases of acute pancreatitis cases. The blood vessel caliper increases at the level of the portal vein, there are echoes in the lumen (slight echoes suggest recent thrombosis, intense echoes suggest old thrombosis!), but there is no Doppler signal at this level.

In splenic vein thrombosis the diagnosis is made indirectly and it is based on the detection of splenomegaly with a progressive character (bipolar diameter is over 120 mm) and on the exacerbation of the colour signal in arteries and veins, in the spleen and at the level of the hilum (which corresponds to a congestive process). The Doppler exploration is useful in order to detect thrombosis and to identify the moment when the circulation becomes portal again either spontaneously or under anticoagulant treatment. This happens in the form of a multi-channel structure with a spongiform appearance in the hilum of the liver (Fig.15). The method is especially valuable in patients with pancreas transplants, in whom venous thrombosis can be identified early and thus the treatment can be rapid and adapted to the specific case. Arterial vascular indices increase rapidly in the case of pancreas rejection.

Posttraumatic fistulae and collections can be detected postoperatively after percutaneous procedures in Wirsung's duct or in patients with posttraumatic duct fractures. The ultrasonic appearance is that of collections irregularly delimited by the presence of peripancreatic inflammatory tissue with variable volume which do not respond to treatment and which are located peripancreatically, sometimes towards the anterior abdominal wall (Fig.16).

The role of US examination in the diagnosis and evaluation of acute pancreatitis. Relationship with other diagnostic methods

The US examination cannot replace more efficient examination methods such as CT or MRI, especially in the case of patients in whom parenchymal necrosis or abscesses of the abdominal cavity have to be detected or when the patients suffer from high meteorism, i.e., when a good quality US image cannot be obtained. However, this method also has important advantages: its portable character (it can be carried out at the patient's bedside), its high accessibility (cheap equipment, lack of invasion, repetitive character), its dynamic character in "real time".

This method is a means of separating severe cases from moderate or mild ones. Images should be interpreted only in relation with the clinical picture and the biochemical data. The clinician should have access to this examination method in emergency rooms and in intensive care units. The clinical picture should guide all further measures to be taken; if complications occur – severe pain, shock, prolonged intestinal paresis, sepsis – CT-scans should be used. If these signs are not present, US correlated with clinical data is usually conclusive. The method is in fact an anatomical examination which can be performed at short time intervals (three days) thus representing a rational and reassuring manner of supervising this disease.

Conclusions

When performed by qualified specialists, US examination allows the diagnosis of acute pancreatitis, its classification in a class of risk and the detection of complications. It cannot replace CT, but because it is not invasive and very accessible, it can represent a valuable method in evaluating the evolution of the disease at short time intervals.

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