CLINICAL IMAGING

The Role of Imaging Methods in Identifying the Causes of Extrahepatic Cholestasis*

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Abstract

Transabdominal ultrasonography is the first choice examination used for the etiological diagnosis of extrahepatic cholestasis because it is a noninvasive, rapid method and presently widely accessible. In this article we discuss the accuracy of transabdominal ultrasonography, computed tomography (CT), endoscopic retrograde cholangiopancreatography (ERCP), magnetic resonance cholangiopancreatography (MRCP) and endoscopic ultrasonography (EUS) in detecting the main causes of extrahepatic colestasis. Although in bile duct pathology, and especially in the evaluation of patients with jaundice, transabdominal ultrasonography is the first choice exploration, helicoidal CT, ERCP and MRCP are often required to establish the local cause of jaundice, local and distant consequences evaluation, appreciation of surgical intervention opportunity and choice of the right therapeutic method.

Key words

Transabdominal ultrasonography - extrahepatic cholestasis - imaging methods

Introduction

Extrahepatic cholestasis is defined as the impossibility of inflow into the duodenum of a normal quantity of bile due to into lesions or obstacles at the level of the choledochus or the common hepatic duct.

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The main causes of extrahepatic cholestasis are: common bile duct (CBD) stones, cholangiocarcinoma, ampullary carcinoma, pancreatic diseases (pancreatic head carcinoma, pseudotumoral chronic pancreatitis, pancreatic head pseudocysts), CBD strictures and congenital malformations (cysts, Caroli disease), duodenal diverticulas, ascaridiasis, hemobilia. CBD dilatation can appear in some particular conditions (postcholecystectomy or in elderly people) without pathological significance.

Transabdominal ultrasonography (TUS) is the first choice examination used for the etiological diagnosis of extrahepatic cholestasis because it is a noninvasive, fast method and presently widely accessible. The main ultrasonographic sign is the dilatation of the principle bile duct over 7 mm, associated, in most cases with intrahepatic bile duct dilatations and/or gallbladder dilatation.

Presently, authors agree that the most accurate assessment for extrahepatic bile ducts obstacle is the increase of the common hepatic duct over 5 mm or the intrahepatic bile ducts diameters over 40% of the accompanying portal branch caliber.

A particular situation is represented by cases with extrahepatic cholestasis without CBD dilatation in patients with transitory or intermittent bile ducts obstruction. In these situations transient increase of bilirubin and cholestasis enzymes is detected but no ultrasonografic modifications of CBD caliber (stone passage).

US evaluation of CBD size frequently leads to lower values compared with radiological procedures as intravenous cholangiography or ERCP. These differences are determined by measurements effectuated at different levels, radiological magnification, choleretic and distension effects due to the contrast substance. Ultrasonographic measurements are performed in the proximal part of the bile duct while the radiological measurements are peformed in the maximum diameter of the bile duct (usually the distal part).

TUS permits distinction between extrahepatic and intrahepatic cholestasis, but has a lower sensibility (50-80%) in identifying the etiology of biliary obstruction. For this

reason, in many situations, it is necessary to combine it with other imaging techniques - endoscopic retrograde cholangiopancreatography (ERCP), computed tomography (CT), endoscopic ultrasonography (EUS) or magnetic resonance cholangiography (MRCP) - that increase the diagnosis accuracy to 95-99%.

CBD stones

Ultrasonographic identification of bile duct dilatations represents an important indicator of stone presence.

The CBD dilatation realizes at the level of hepatic hilum *the double shot gun* sign. A particular ultrasonographic aspect is represented by *passage choledoch.* Small gallbladder stones can pass through CBD and can be spontaneously eliminated without realizing a permanent biliary obstacle. The recurrence of this obstruction leads to loss of the CBD wall elastic properties and persistence of dilatation.

Ultrasound specificity for CBD stones diagnosis is 95-100% but, the sensitivity is lower (58-68%) and even lower if the stones have less than 1 cm (1-4) (Fig.1).

Ultrasonographic modern methods (tissue harmonic imaging, 3D examination) increase the examination sensibility and allow to obtain images as accurate as ERCP or MRCP.

TUS is also necessary for selecting patients who will undergo ERCP examination before laparoscopic cholecystectomy. Rigorous criteria of selection must be used (CBD stones ultrasonographically visualized and/or jaundice), criteria which permit a significant decrease of incidents and accidents inherent to an invasive procedure (Fig.2).

MRCP visualizes pancreatic and billiary ducts and obtains similar images as ERCP, without using contrast substance (5). CBD stones are easily identified on T_2 ponderate images, but the method has a higher cost than TUS.

EUS allows evaluation of extrahepatic cholestasis because of the excellent visualization of extrahepatic bile ducts by duodenal placing of the transductor and avoiding of intestinal gas. Intrahepatic bile duct visualization is more difficult especially for the right lobe because of the ultrasound limited penetration. Small CBD stones (under 3-4 mm) can be observed at ERCP with superior accuracy even if they do not have acoustic shadow. EUS permits the establishing of the number, location and stone size, cystic and bile ducts diameters, cystic duct implantation, gallbladder aspect (Fig.3). The sensitivity of the method is over 90% and its specificity is over 95% for CBD stones diagnosis, with higher accuracy than TUS or CT. The disadvantages are long-time learning and the high cost of necessary equipment.

In conclusion, TUS remains the first method used to diagnose bile duct stones because of its simplicity and high specificity. Tissue harmonics and 3D examination lead to high quality images and obviously the improvement of the method's sensitivity.

Cholangiocarcinoma

Bile ducts carcinoma (cholangiocarcinoma) can spread to the entire billiary tract and, when situated in the hepatic hilum invading the hepatic confluence, it is called Klatskin tumor.

At TUS, it is visualized as a tissular formation which is prominent in the bile duct lumen and determines their proximal dilatation. Some forms progress only with a discreet thickness of the bile ducts wall without direct visualization of the tumor. The distal forms evolve with the dilatation of the entire billiary tract, inclusively the gallbladder and, sometimes, with portal vein invasion (malignant thrombosis) (6,7) (Fig.4).

Klatskin tumor determines only intrahepatic bile ducts dilatations, with impossible visualization of right and left hepatic duct confluent. Cholangiocarcinoma must be ultrasonographically differentiated from hepatocarcinoma or gallbladder carcinoma with bile duct invasion (for Klatskin tumor), or by pancreatic head carcinoma and ampullary carcinoma (for distal cholangiocarcinoma). Intrahepatic bile duct tumors must be differentiated by primary sclerosing cholangitis (intrahepatic bile ducts dilatations not so obvious) (8-10).

TUS in these situations must be associated with other imaging methods.

Technical progress in EUS allows visualization of hepatic hilum by using low frequency transductors (5 MHz) with high penetration or intraductal EUS with endoscopically or percutaneously introduced transductors (11) (Fig.5).

CT and CT cholangiography have a better accuracy compared with TUS, especially the spiral technique, which allows a precise evaluation of the transition area between dilated and undilated zone of CBD. Blunt termination of CBD is a cholangiographical sign correlated with malignancy, while progressive narrowing is an argument for benign stenosis. Focal, excentric thickening of the main bile duct proximal to obstruction is suggestive for a cholangiocarcinoma.

ERCP and MRCP sensitivity are similar in cholangiocarcinoma diagnosis; one of the major advantages of ERCP is the possibility of collecting tissue samples by brush procedure for etiological diagnosis of biliary stenosis (Fig. 6).

Ampullary carcinoma

TUS shows indirect signs of the tumor: intra and extrahepatic bile duct dilatations, gallbladder enlargement with "sludge" in high quantity. Rarely is the ampular tumor visualized as a round or oval hypoechoic formation relatively well defined, which is situated between the dilated CBD and duodenum (Fig.7).

TUS shows secondary changes (hepatic metastases, hepatic hilum lymph nodes and ascites in peritoneand carcinomatosis) and color Doppler technique is useful for the appreciation of local vascular invasion (12,13).

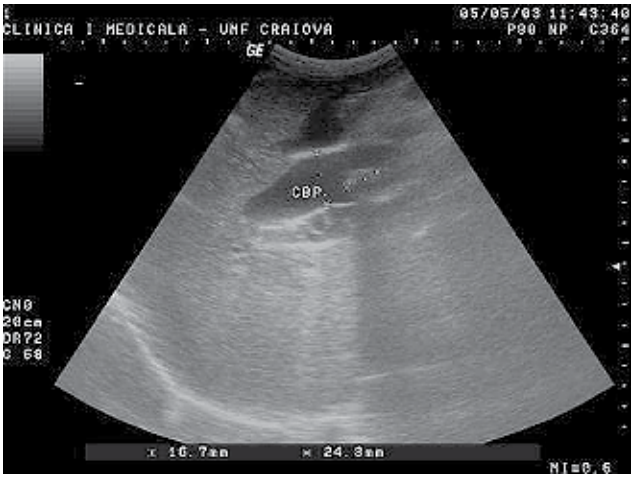

Fig.1 Transabdominal ultrasonography: common bile duct stone.

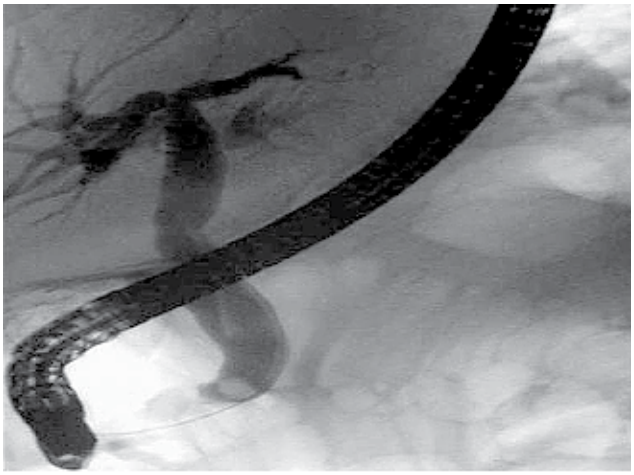

Fig.2 Endoscopic retrograde cholangiopancreatography: common bile duct stone.

Fig.3 Endoscopic ultrasonography: common bile duct stone.

CT scan detects periampullary formations over 2 cm with accuracy over 90% but it does not permit differential diagnosis of these tumors. If the ampullary carcinoma is small (under 2 cm), the CT scan shows only bile duct or pancreatic duct dilatation (14,15).

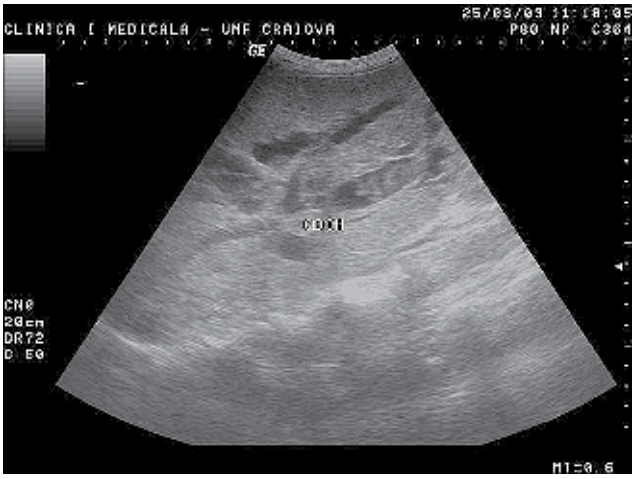

Fig.4 Transabdominal ultrasonography: cholangiocarcinoma (billiary tract dilatation).

Fig.5 Endoscopic ultrasonography: cholangiocarcinoma – visualisation of hepatic hilum.

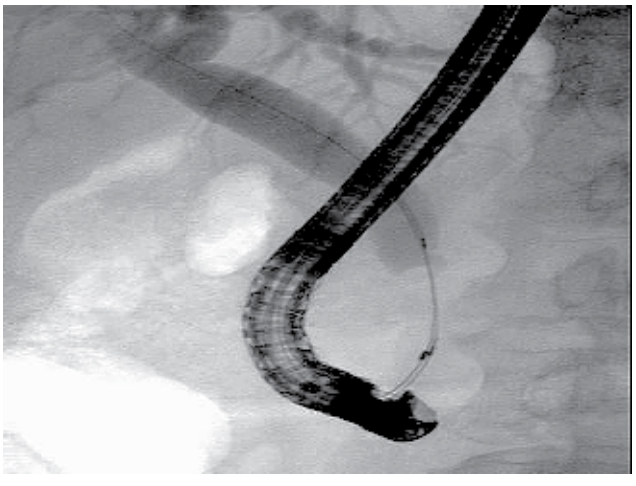

Fig.6 Endoscopic retrograde cholangiopancreatography: cholangiocarcinoma.

EUS allows visualization of duodenal papilla as a round or oval hypoechoic formation with over 5 mm size (normal diameter of Vater's ampulla) from which dilated pancreatic and CBD start. The method permits detection of ampullary

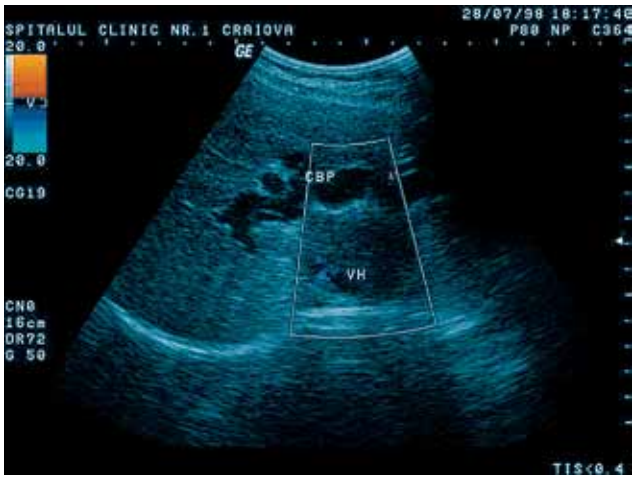

Fig.7 Transabdominal ultrasonography: ampullary carcinoma.

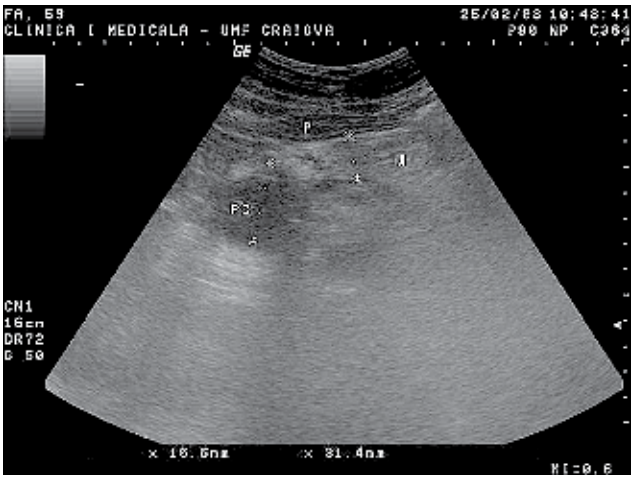

Fig.10 Transabdominal ultrasonography: pancreatic head pseudocyst.

Fig.8 Endoscopic image in ampullary carcinoma.

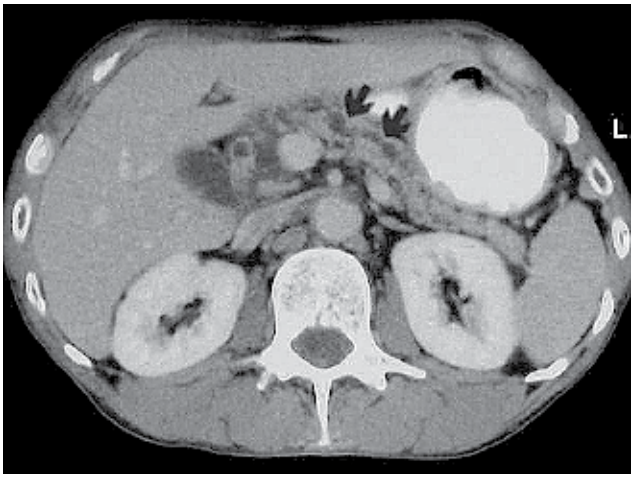

Fig.11 Computed tomography: pancreatic pseudocyst.

Fig.9 Endoscopic ultrasonography: ampullary carcinoma.

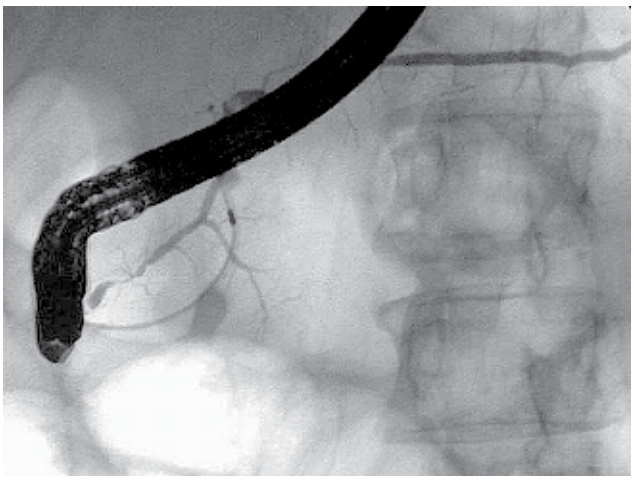

Fig.12 Endoscopic retrograde cholangiopancreatography: stenoses and dilatations of Wirsung duct in chronic pancreatitis.

tumors in 93% of the cases comparatively with 7% by TUS and respectively 29% by CT (16-18) (Figs. 8,9).

Although ERCP is essential for ampullary carcinoma diagnosis, local tumor extension and regional lymph node metastasis can be evaluated only by EUS. The two methods are complementary because EUS does not allow differentiation between benign and malignant ampular tumors. Upper digestive endoscopy and ERCP remain the principal diagnostic methods for ampullary carcinoma because they permit correct localization and biopsy col-

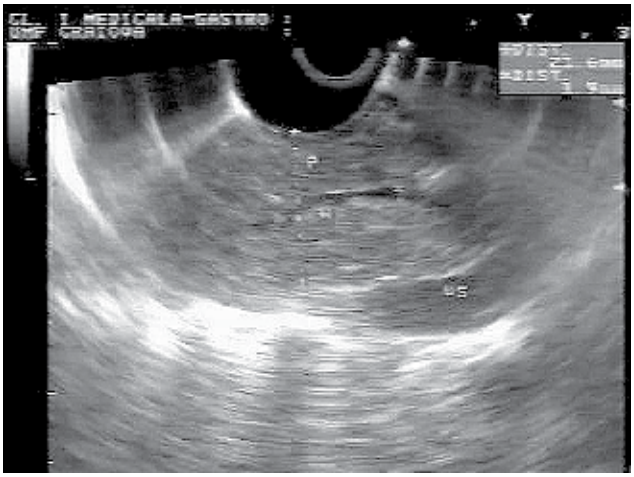

Fig.13 Endoscopic ultrasonography: chronic pancreatitis.

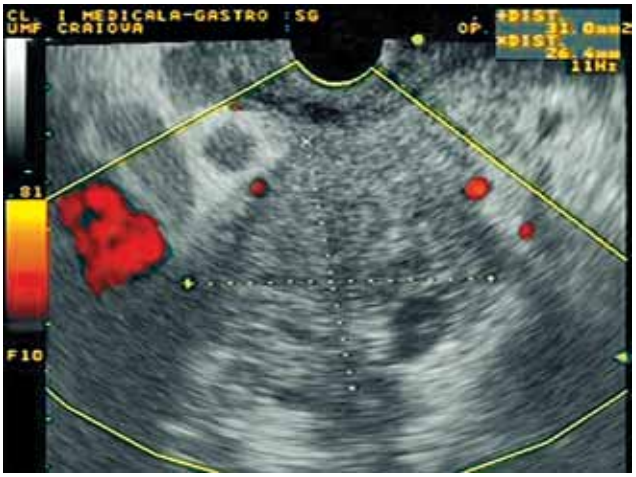

Fig.16 Endoscopic ultrasonography: pancreatic head adenocarcinoma.

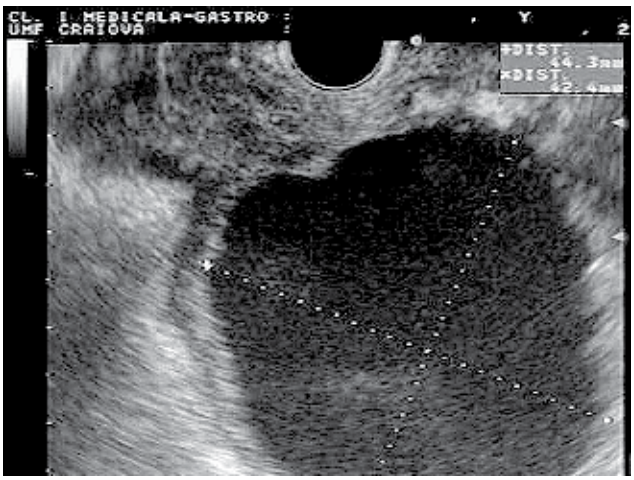

Fig.14 Endoscopic ultrasonography: pancreatic pseudocyst.

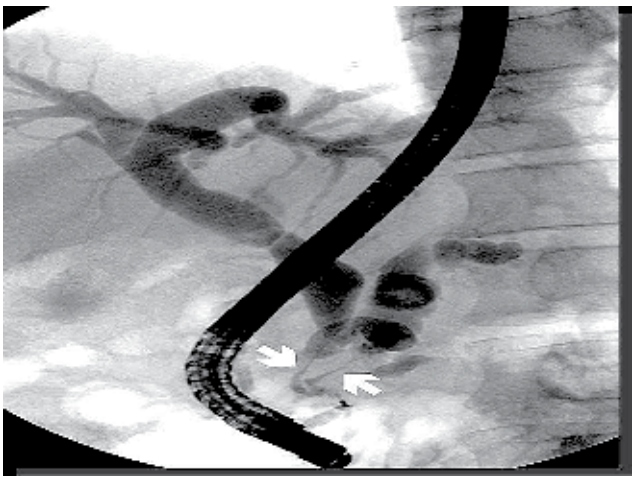

Fig.17 Endoscopic retrograde cholangiopancreatography: pancreatic head adenocarcinoma with retrograde dilatations of bile ducts and Wirsung duct.

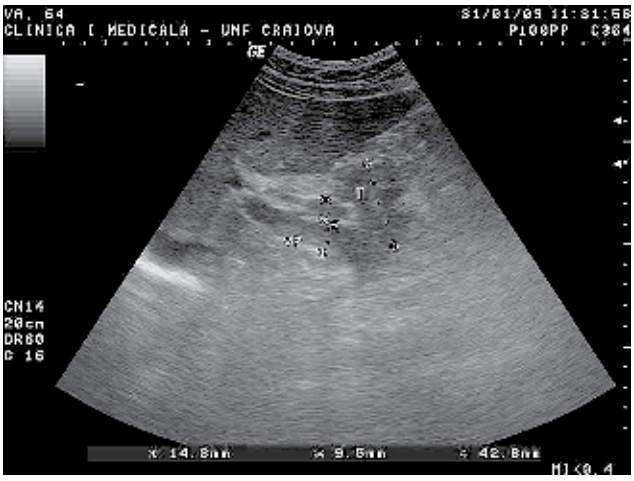

Fig.15 Transabdominal ultrasonography: pancreatic head adenocarcinoma.

Fig.18 Transabdominal ultrasonography: common bile duct cyst.

lecting under directly visually control. Lateral view endoscope tubes facilitate papilla visualization and biopsy or brush procedure from stenosis. ERCP is also useful for excluding other causes of extrahepatic cholestasis and for therapeutic interventions (ampullectomy, endoscopic sphincterotomy with/without stenting) (19).

Pancreatic diseases which cause extrahepatic cholestasis

Acute pancreatitis. TUS has a limited role because of examination difficulties caused by dynamic ileus or obesity. The method is efficient in tracking down the trigger causes (gallbladder lithiasis with migrated stones) or in visualizing complications (pancreatic head pseudocysts which determine extrahepatic cholestasis and for percutane drainage of these collections (20,21).

CT scan is superior to TUS because it permits a better visualization of glandular changes and those from pancreatic area, quantification of lesion severity and visualization of local and distal complications (22).

Chronic pancreatitis – pseudotumoral form. At TUS the pancreas structure appears intensely inhomogeneous, with visualization of some nodular, tissular formations, relatively well defined which imposes differential diagnosis with pancreatic tumors and frequently realizes compression on neighboring structures (CBD, duodenum, stomach, splenic vein). The absence of neighboring lymph node and hepatic metastases pleads for pancreatic benign tumors, but EUS-guided fine needle aspiration is required to be certain.

Pancreatic head pseudocysts which appear in chronic pancreatitis can be ultrasonographically visualized as transonic formations well delimitated distorting the capsule and the border of the organ. In evolution, the wall of these tumors becomes thicker (over 3 mm) and indicates surgical intervention. The echoic circumscribed images inside the pseudocysts are suggestive for the presence of sequesters (23) (Fig.10).

CT is necessary when the information offered by TUS is insufficient and inconclusive. It is a sensible method which shows small calcifications unvisualized by other methods, pancreatic pseudocysts and also their contacts with neighboring vessels and organs (Fig.11).

ERCP is the most precise method for diagnosing obstructive chronic pancreatitis because it permits visualization of Wirsung collaterals which are dilated and with irregular caliber even in early phases of the disease. In the case of pseudocysts, ERCP shows the number, localization and size as well as eventual communication with intrapancreatic canales (Fig.12).

EUS has a better sensitivity as compared with TUS and CT (88% versus 56% respectively 75%). The method permits an early diagnosis of morphological changes before the alteration of pancreatic functional tests and allows also invasive procedures (EUS-guided fine needle aspiration or drainage of localized collections) (Figs.13,14).

Pancreatic head adenocarcinoma

The adenocarcinoma is visualized at TUS as a tissular tumor with a hypoechoic aspect compared with the rest of pancreatic parenchyma, which has signs of invasion or compression on CBD with significant dilatation. On oblique sections at the level of hepatic hilum, terminal CBD shows narrowing with *pencil top* aspect, secondary to tumoral compression. Wirsung duct is proximally dilated (caliber over 20 mm) (24,25) (Fig.15).

CT is superior to TUS because it allows a better visualization of pancreatic tumors inclusively in obese patients and in patients with meteorism. Its accuracy is 95% in detecting pancreatic cancer and its sensibility is 92% (for helicoidal CT). The optimal sequences are obtained on arterial and portal phases, with in bolus introduction of contrast to determine the high levels of pancreatic capture. The helicoidal CT examination is useful also for appreciating distal invasion at the level of the liver, peritoneum, lymph nods or vessels and for guiding fine needle aspiration for tumor diagnosis (26,27).

MRI and MRCP do not offer significant advantages over CT because of the movement artifacts, intestinal gas opacities and spatial resolution inferior to helicoidal CT (28).

EUS is useful for pancreatic cancer staging and in the appreciation of vascular invasion (accuracy 72-90%) but does not allow visualization of distant hepatic and lymph node metastases (Fig. 16). Helicoidal CT is inferior to EUS in small tumor detection and staging, and for the assessment of tumor resectability (accuracy 83% vs 91%) but has the advantage of good visualization of metastases.

ERCP is considered the best imaging method for pancreatic head cancer diagnosis with a sensitivity of 95% and specificity of 85%, and the cytological sample obtained from pancreatic duct can establish the malignancy diagnosis with a sensitivity of 60% (Fig.17).

CBD cysts

TUS visualization of cystic dilatations is easy (29) (Fig.18), but differential diagnosis difficulties with gallbladder malformations, simple hepatic cysts, pancreas head cysts etc. can appear, which can hinder the information offered by CT, ERCP or EUS.

Conclusions

In bile duct pathology and especially in patients with jaundice, TUS is the first choice exploration following medical history and clinical examination.

TUS offers rapid information which allows in most cases the differentiation between extrahepatic and intrahepatic cholestasis.

The use of the new techniques (Doppler, tissue harmonic, contrast agents, 3D examination) improves significantly the image quality and facilitates the etiological diagnosis in extrahepatic malignant cholestasis.

The association between EUS, helicoidal CT, ERCP or MRCP is often necessary for identifying the cause of jaundice, for local and systemic evaluation, for indicating the surgical intervention and choosing the right therapeutic method.

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