Ultrasound of the pancreas: update and controversies

Abstract The pancreas is an organ that often presents difficulties for ultrasound exploration due to the interference of abdominal gas in the stomach and duodenum. However, with technical experience and the use of a variety of examination techniques, such as filling the stomach with water or cellulose suspension, changing patient’s position, or scanning at different moments of respiration, such as suspended inspiration or expiration, it can be seen in its totality in a high percentage of patients. In our opinion, especially as new technical advances have been incorporated into US equipment (color power Doppler, harmonics, and US pulse inversion) and new contrast agents are available, US can compete with CT in this field. Ultrasound can be as useful as CT in most patients with pancreatitis and pancreatic neoplasms. Furthermore, Endoscopic sonography (ES), as well as intraoperative and laparoscopic techniques, are also excellent for visualizing malignant pancreatic lesions and have a special role in preoperative staging. Finally, US is a good technique to guide fine-needle biopsy of the pancreas and for aspiration of inflammatory fluid collections and abscesses. Although CT has played a major role to date, US is presently the most widely available and economical means to visualize the pancreas.

Keywords Pancreas · Ultrasound · Inflammatory lesions · Neoplasms · Interventional procedures

Introduction

Ultrasound is the technique of choice for initial evaluation of pancreas pathology. It has been reported that the pancreas can be seen by US in a high percentage of patients (93%), independently of fat and gastrointestinal gas interference [1]. Ultrasound examination of the pancreas is performed following a minimum fast of 6 h and technical experience is of particular importance when difficulties are encountered in identification of all different portions of the gland. In order to obtain complete visualization it is convenient to use a variety of scanning techniques, such as filling the stomach with water, alone or mixed with simethicone, examining the patient at different mechanisms, including suspended inspiration or expiration, and changing the patient’s position to erect, supine, and left and right decubitus (Fig. 1) [1, 2, 3]. In recent years, tissue harmonic imaging (THI) has been included as a routine technique in all abdominal US examinations. In our experience it has helped considerably in obtaining better-quality anatomical images, especially in the pancreatic area, through increase of the signal-to-noise ratio and reduction of reverberation artifacts produced by the body wall [4]. The pancreatic area is sometimes difficult to visualize due to poor contrast between fat and gland and between healthy parenchyma and tumors. A recent study [5] showed that harmonic sonography was significantly better than conventional sonography of the pancreas for penetration detail and overall image quality.
Visualization of the pancreatic duct and the common bile duct has also been improved. Ultrasound Doppler techniques are used to evaluate the portal venous system and arterial vasculature in abdominal studies. Power Doppler imaging has been demonstrated to improve the sensitivity for detection of small internal vessels in most lesions. Use of microbubble contrast with harmonic gray-scale imaging or pulse inversion technique can demonstrate the large vessels without the problem of motion artifacts and offers the prospect of vascular information previously obtainable only with triple-phase CT [6].

The aims of this review are to summarize the basic concepts and new applications of pancreas US, to describe the US appearance in pancreatitis and pancreatic neoplasms, and, finally, to determine the role of US in interventional procedures of the pancreas.

**Normal anatomy: vascular and ductal landmarks**

The pancreas is usually located at the level of the first or second lumbar vertebra; however, depending on the phase of respiration, it may be found at a slightly caudal or cranial level. The texture, size, contour, and all anatomic portions of the pancreas should always be evaluated. The normal pancreas is usually homogeneous and its echogenicity is isoechoic or hyperechoic as compared with the normal liver (Fig. 2a). Fatty replacement (lipomatosis) of the pancreas is a common finding with age and in up to 35% of cases the gland may be as echogenic as the adjacent retroperitoneal fat (Fig. 3) [2, 7]. The size of the pancreas is related to body habitus and decreases with age. It is thus difficult to provide limits to its dimensions. The following figures relate to thickness and are orientative only: head (2 cm); neck (<1.0 cm); body and tail (1-2 cm). Structures surrounding the pancreas may be misinterpreted for the gland: the third part of the duodenum, lymph nodes, horseshoe kidney, or a papillary process of the caudate lobe (Fig. 4) [2, 8].

The pancreatic duct (duct of Wirsung) is seen most frequently in the body and less frequently in the tail. It appears as a thin hypoechoic line bordered by two echogenic margins. The upper limit of the main duct in young adults is 3 mm and in the elderly 5 mm (Fig. 2b). Sometimes, the accessory duct of Santorini can be identified in the pancreatic head. Up to 25% of patients with recurrent idiopathic pancreatitis present pancreas divisum, a secondary lack of fusion of dorsal and ventral pancreatic ducts. This anomaly occurs in 10% of the general population [7]. Other pancreatic duct anomalies are agenesis, hypoplasia, annular pancreas, and pancreatic ectopia. The secretine stimulation test increases duct size in 70–100% of normal volunteers. This test could thus be helpful in diagnosis of chronic pancreatitis and functional ductal obstruction [9].

In order to obtain a clear delineation of the pancreas, all surrounding vascular and ductal landmarks should be identified: portal vein; splenic vein; superior mesenteric artery; superior mesenteric vein; aorta; and inferior...