Ultrasonography of the Pancreas

Giulia A. Zamboni, MD*, Maria Chiara Ambrosetti, MD, Mirko D'Onofrio, MD, Roberto Pozzi Mucelli, MD

KEYWORDS

• Ultrasonography • Pancreatic ultrasound
• Pancreatic diseases • Contrast-enhanced ultrasonography

Although the pancreas is often thought of as an organ that is difficult to explore using ultrasound (US), due to its deep retroperitoneal location, with the appropriate technique it can be studied successfully in most patients. US can provide information that is useful for diagnosis of pathologic conditions, especially with the use of harmonic imaging, color-Doppler, and contrast agent administration.

EXAMINATION TECHNIQUES

To improve visualization of the pancreas, the ultrasound (US) examination is usually performed after at least 6 hours of fasting. In this way, the presence of bowel gas is limited, the stomach is empty of food, and the entire organ can be visualized. Nevertheless, technical success is also dependent on the skill and persistence of the examiner.[1]

US should be performed routinely along multiple scan planes, including transverse, longitudinal, and angled oblique, to visualize the entire organ: the head with the uncinate process, the body, and the tail. These multiple scan planes should allow examination of the entire pancreas in at least 2 views. When needed, the spleen can be used as an acoustic window to visualize the pancreatic tail.

When visualization of the pancreas is limited, it is possible to use other scanning techniques, such as moving the transducer and applying compression to displace bowel gas, filling the stomach with water, examining the patient in suspended inspiration or expiration, and changing the patient to a decubitus position.

Conventional gray-scale US with multifrequency transducers is usually the first step when examining the pancreas, selecting the best frequency for each depth. Usually, convex probes are used, with frequencies ranging between 3 and 5 MHz. Doppler frequency must be set to record flows from deep abdominal vessels (1–4 MHz). Lower Doppler frequencies allow better penetration and are used to evaluate the peripancreatic vessels, whereas higher Doppler frequencies are useful for evaluating slower flows in thin patients whose pancreas is more superficial.[2]

Tissue Harmonic Imaging

The routine examination technique should include the use of tissue harmonic imaging (THI), which can improve visualization of the pancreas by increasing the signal-to-noise ratio and reducing the reverberation artifacts from the body wall, especially when studying large patients or deep structures. Shapiro and colleagues[3] demonstrated that harmonic imaging had better penetration detail and overall image quality than conventional US. In a prospective study on 107 patients, Hohl and colleagues[4] demonstrated that sensitivity for the detection of pancreatic lesions with THI using the phase inversion technique was higher than for conventional B-mode US.

Color-Doppler and Power-Doppler Ultrasound

Doppler ultrasound is another fundamental part of the conventional US examination for evaluating the peripancreatic vessels (portal vein, superior

Disclosures: G.A.Z., M.C.A., and R.P.M. have no disclosures. M.D. was an Advisory Board member, Siemens Healthcare (2010).
Istituto di Radiologia, Policlinico GB Rossi, Azienda Ospedaliera Universitaria Integrata Verona, P.le LA Scuro 10, 37134 Verona, Italy
* Corresponding author.
E-mail address: gzamboni@hotmail.com

Radiol Clin N Am 50 (2012) 395–406
doi:10.1016/j.rcl.2012.03.010

mesenteric artery and vein, splenic artery and vein, aorta and inferior vena cava). Doppler imaging allows the visualization of smaller peripancreatic and intrapancreatic vessels, and at the same time the assessment of patency and characteristics of blood flow.[2]

The normal color-Doppler and pulsed-Doppler features of peripancreatic vessels in healthy subjects are well known[5]: the mean flow velocity is about 103 ± 18 cm/s in the celiac trunk, 78 ± 16 cm/s in the hepatic artery, 85 ± 18 cm/s in the splenic artery, 100 ± 22 cm/s in the superior mesenteric artery,[2] and 12 to 20 cm/s in the portal vein.[2] The resistance index in the superior mesenteric artery is general higher than in the other arterial vessels.[2]

Contrast-Enhanced Ultrasound

Contrast-enhanced ultrasound (CEUS) with second-generation contrast agents is not currently approved by the Food and Drug Administration for the study of solid abdominal organs in the United States, but is used in many other countries for the study of the pancreas and other abdominal organs.

CEUS with second-generation contrast agents (Sonovue, Bracco, Milan, Italy; Sonazoid, GE Health care, Oslo, Norway; Optison, GE Health care, NJ, USA; Definity, Lantheus Medical Imaging, MA, USA) and the use of contrast-specific US techniques allows a continuous dynamic observation of pancreatic parenchymography. CEUS can, therefore, be used for a better identification of pancreatic lesions as compared with conventional US and for characterization and staging of focal lesions already identified at US.[6]

The technique of CEUS of the pancreas should vary according to the clinical indication.[6] The patient should be in the position that provides the best visualization of the area of interest in the pancreas, most commonly the supine position. Harmonic microbubble (MB)-specific imaging with a low acoustic US pressure (mechanical index <0.2) is required for a dynamic CEUS examination: with specific US software, the background tissue signals are canceled and only the signals related the responses of the MBs are visualized. In our institution, we routinely administer a 2.4-mL intravenous bolus of second-generation contrast agent, constituted of sulfur hexafluoride–filled MBs with a phospholipid peripheral shell (SonoVue, Bracco) followed by a 5-mL saline flush. The enhancement is evaluated in real time, maintaining the same scanning frame rate as in the previous conventional gray-scale examination. The dynamic continuous observation of the contrast-enhanced phases (arterial, portal/venous, and late phases) starts immediately after the contrast agent injection.[7] Still images or clips are saved according to the radiologist's preferences; however, most often still images are saved for the baseline and delayed parts of the examination, whereas clips are saved for the early arterial and parenchymographic phases (starting from the arrival of the contrast in the aorta).

In our institution, the most common indication is characterization and staging of focal lesions: the lesion must be examined in the arterial, pancreatic, and venous contrast-enhanced phases. The relationship with the peripancreatic vessels must be assessed. With second-generation agents, after the study of the pancreas, the liver can be studied in the delayed "sinusoidal" phase to exclude the presence of liver metastases[8]; for the study of the liver, the left lateral decubitus position may be useful.

When the objective is detection or study of a small pancreatic lesion, often the case for endocrine tumors, 2 boluses of contrast agent can be used, each of 2.4 mL, to be able to explore all the portions of the pancreas in the arterial phase.[6] Also, the use of a high–acoustic pressure flash, which almost completely eliminates saturation of the area immediately adjacent to the parenchyma already studied by disrupting the MBs, can provide another pure arterial phase.

The complete examination of the pancreas (**Box 1**) should include the evaluation of size, contour, and texture of the gland, and the echo pattern of the head, body, and tail (**Fig. 1**). The main pancreatic duct and the common bile duct must be identified, as well as the major peripancreatic vessels, such as the portal vein, superior mesenteric artery and vein, splenic artery and vein, and aorta and inferior vena cava.

NORMAL ANATOMY

The pancreas is located at the level of the first or second lumbar vertebra in the retroperitoneal

Box 1
What to look for in pancreatic US

- Size
- Contour
- Texture
- Echogenicity
- Main pancreatic duct
- Common bile duct
- Major peripancreatic vessels (portal vein, superior mesenteric artery and vein, splenic artery and vein, aorta and inferior vena cava)