Ultrasonography of the spleen. Pictorial essay.

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Abstract

Contrast-enhanced ultrasound is widely indicated in the study of splenic diseases, especially due to its good specificity in the differentiation of benign from malignant splenic lesions. The purpose of this pictorial essay is to offer a review of the most common splenic pathologies, while illustrating them with sonographic images.

Keywords: spleen, ultrasonography, contrast-enhanced ultrasound, colour-Doppler, elastography

Introduction

Ultrasonography (US) is extensively used in imaging the abdomen, being frequently the first method of choice for an abdominal survey. As part of the abdominal US examination, US of the spleen still plays an important role in diagnosis, even though other imagistic modalities are becoming increasingly competitive [1].

Even if it has been named ‘the forgotten organ’, careful examination of the spleen can bring important diagnostic clues in pathologies such as oncologic, hematologic, infectious, and metabolic, abdominal trauma, portal hypertension, and many other focal or diffuse splenic changes of different etiologies.

Examination Technique

The spleen should be examined with the patient on their back or right side, using a 3-5 MHz curved linear transducer while the patient exhales in order to avoid spleen coverage by the left lung tissue. The best window to view the spleen is at the level of 10th or 11th intercostal spaces, on the left midaxillary line. Colour Doppler imaging may sometimes assist in an accurate diagnosis, but it can only assess the macrocirculation. Contrast-enhanced US (CEUS) can assess both macro- and microcirculation in real-time. It requires a skilled user, being highly operator dependent. The examination should be made using a high-frequency transducer, and tissue harmonic imaging in the presence of an echogenicity slightly greater than that of normal hepatic parenchyma [6]. At CEUS, the phases of contrast enhancement are broadly divided into arterial (10–25 s), portal venous (30–120 s), and late phases (over 120 s) [7]. During the arterial time, the arterial splenic vessels are displayed (fig 1a), while in the portal venous phase, the splenic parenchyma becomes homogenously enhanced (also called the parenchymal phase) (fig 1b).

Abnormal Findings

Focal lesions in the spleen are rare in comparison with those located in other solid viscera. The accurate analysis of internal architecture of the lesion can give us important diagnostic clues, due to the US’s ability in depicting the calcifications (long term process) or gas within a lesion (usually originating from bacterial infection), those being most frequently related to benign findings. The malignant lesions are more frequently multifocal (especially metastasis), and tend to be diffuse and ill-defined due to rapid growth [8]. Because the US appearance of disease in the spleen is rather nonspecific, a thorough knowledge of the patient’s history and associated symptoms may be very helpful in the differential diagnosis [6].

Different patterns of enhancement for focal splenic lesions have been described at CEUS examination: benign lesions that have constantly nonenhancing or isoenhancing pattern and malignant lesions with enhancement in arterial time, followed by rapid wash-out, or progressively hypoechoic with heterogeneous aspect. This last aspect was described in some studies as having 100% sensitivity, and 83% specificity for malignancy [2,3,9-12].

Diffuse Splenic Disease

The basic finding in many diseases of the spleen is the acute or chronic increase in the size of the organ. Splenomegaly can be caused by infections, liver or blood diseases, problems with the lymph system, or other conditions [5].
Presence of an enlarged spleen may need fusion of multiple images or the use of panoramic images in order to view the entire organ (fig 2a). The aspect of enhancement in CEUS is nonspecific and inconstant (fig 2b). In marked splenomegaly, a delay in contrast uptake and a less intense opacification of splenic parenchyma may be found [2]. The elastogram may present with an inhomogeneous pattern, with stiffer areas located subcapsular, due to enlarged parenchyma compressed under the splenic capsule (fig 2c).

**Focal Splenic Lesions**

**Cysts**

Cysts are the most common benign lesions of the spleen, and usually present no diagnostic problems. They may be primary or acquired. The primary ones are true cysts, with epithelium, endothelium, and membrane lining, and may be congenital, parasitic, or neoplastic. Most often primary cysts are simple, uniloculated, but they may also present incomplete septations, or punctate calcifications. The secondary cysts, “false”, have no cellular lining, and may be the result of a trauma, a degenerative evolution of a splenic infarction, or a post-necrotic evolution of an abscess. In these cases, due to bleeding or necrosis, the result is a mixed echographic pattern, partially cystic. The differential diagnosis may be difficult, and a puncture may be needed (fig 3, fig 4) [8,13-15].

**Infarction**

Infarct usually appears as triangular hypoechoic areas, with the base on the splenic capsule and pointing towards the hilum, without vascular signal inside. The margins of the lesion can be irregular, ill-defined (especially in the acute stage), or well delineated, and the texture may be homogenous or inhomogeneous. On CEUS, it is immediately recognized due to total absence of enhancement. The interrupted artery may be visible in the arterial time. It has a high tendency to spontaneous healing (fig 5-7) [2,10,13].

**Abscess**

Splenic abscess is rare and represents a collection of pus commonly caused by hematogenous spread of infection. Micro-abscesses in patients with bacterial endocarditis, or infectious complications of hematomas or infarctions may also be encountered [6]. They have various and nonspecific sonographic appearances, depending on their etiology and size. Large abscesses are often hypoechoic, with a thick irregular wall [16]. They show no uptake of contrast agent at CEUS, but may present a hyperchoic, enhancing rim. Enhancing septa may be seen, but no sign of contrast microcirculation is seen within the internal fluid, debris, and necrotic components (fig 8) [10,17,18]. Due to the need of rapid diagnosis and early treatment, percutaneous fine-needle aspiration guided by sonography is required as soon as the suspicion has been raised, especially because the clinical diagnostic triad is present in only 44% of cases [13,19].

**Hemangiomas**

Hemangiomas is the most common benign solid lesion of the spleen characterized by a proliferation of blood-filled spaces lined and separated by the endothelium. It is usually a solitary, well-marginated lesion, having less than 2 cm in size. The sonographical appearance is different for the two histological types of hemangiomas: the cavernous hemangioma appears as a mixed echogenic or hypoechoic structure, with possible calcifications or cystic component; a capillary hemangioma is hyperechoic, with well-defined margins. The most frequent complications are rupture and bleeding [1,6,13]. At CEUS, capillary hemangiomas are usually isoenhancing with the ad-
acent splenic parenchyma. A hyperechoic splenic lesion on gray-scale, undetectable after contrast-agent administration is diagnosed as a hemangioma [10]. Cavernous hemangiomas can present a diffuse or centripetal filling-in, rapid or slow, but with a greater enhancement degree (fig 9, fig 10) [2].

Trauma
Computed-tomography is the reference standard in detecting and monitoring splenic trauma [1]. Fissures may be hyperechoic or hypoechoic compared to splenic parenchyma, contusions appear as slightly hypoechoic, ill-defined areas, and lacerations may be seen as clearly hypoechoic band, linear or branched, perpendicular to the splenic surface [2,20]. A fresh hematoma imposes a hyperechoic structural change within the splenic parenchyma, while an organized hematoma shows a varied echogenic structure, and a decreased or a lack of contrast agent uptake at CEUS, better evident during the late phase of enhancement [1,21]. More severe lesions can also cause a subcapsular hematoma. Free fluid in the perisplenic region of the abdominal cavity is an indirect sign of a ruptured spleen [22].

Color Doppler and CEUS are helpful in detecting hemorrhage and posttraumatic splenic pseudoaneurysms. With CEUS the acute hemorrhages and pseudoaneurysms are indicated by an early-phase hyperechoic pool or jet within the splenic parenchyma or perisplenic hematomas (fig 11-14) [21].

Lymphoma
Lymphoma is one of the most common primary malignancy of the spleen, being more common than splenic metastases. The spleen usually is larger, but a normal
**Fig 12.** Subcapsular splenic hematoma. a) peripheral crescent-shaped hematoma; b) no contrast-agent extravasation inside the hematoma was seen, which represents absence of active bleeding at the time the examination was performed (S = spleen, H = hematoma).

**Fig 13.** Large subcapsular hematoma. a) Absence of vascular Doppler signal inside hematoma; b) absence of contrast-agent extravasation inside hematoma, excluding active bleeding at examination time; c) surgically resected spleen – the large subcapsular hematoma is evident; d) abdominal contrast-enhanced CT scan, arterial time – subcapsular splenic hematoma, with inhomogeneous content, and perihepatic ascites (S = spleen, H = hematoma).

**Fig 14.** Old hematoma at CEUS. a) early arterial time – the hematoma has a clear content, without contrast-agent inside; b) late arterial time – no extravasation of contrast inside the large hematoma (H = hematoma).
The lesions are hypoechoic in most of the cases, showing different US patterns: lesions smaller than 1 cm in diameter, with focal (miliary and nodular) or diffuse (infiltrative and diffuse) (fig 15, fig 16) destruction of splenic parenchyma (typical for non-Hodgkin lymphoma of low-grade malignancy), or focal lesions larger than 3 cm, cyst-like (fig 17) (high-grade non-Hodgkin lymphoma). The indistinct boundary echo pattern is an important clue in differentiating them from cysts [6,25]. They are becoming more evident at CEUS as hypoechoic defects, less enhancing than the surrounding parenchyma, with lesion to parenchymal gradient progressively increasing while moving to the parenchymal phase. Especially in the diffuse form, it is difficult to be distinguished from hematogenous metastases. The lymphoma lesions are usually regularly deposited, while metastases are usually anarchically disposed [2,13,26]. Lesions with increased echogenicity are unusual in patients with lymphoma, and require histological confirmation [2,13].

Metastasis

Splenic metastases are rare lesions, usually seen in patients with advanced malignant disease, having a poor prognosis. The most frequent metastases are from lymphoma and melanoma, followed by carcinoma of the ovary, breast, lung, stomach, prostate, colon, liver, and pancreas [5,8]. As in malignant lymphoma, splenic metastases are predominantly hypoechoic, target lesions with a hypoechoic halo being suggestive for metastasis (sign of aggressive behavior) [13]. Sometimes hyperechoic (eg, carcinoma of the colon) or inhomogeneous lesions with a necrotic center can be found (rapid growth...
or mucinous origin — eg, ovarian carcinoma). With the exception of metastases of mucinous primary tumors, calcifications are rarely seen (fig 18-20) [27-29].

Conclusion

Sonography is a widely available, noninvasive, useful and valuable tool for diagnosing and follow-ups of splenic abnormalities, both benign and malignant. The additional use of CEUS can improve its diagnostic validity, especially when interpreted in the clinical context of the case. In many cases, pathologic confirmation is necessary to make a definitive diagnosis.

References: