Contrast enhanced ultrasound of the spleen: A pictorial review of the most common pathologic conditions

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Learning objectives

To present an examination protocol of contrast enhanced ultrasound (CEUS) of the spleen. To review and understand underlying pathophysiology. To show examples of the commonest pathologic entities of the spleen on CEUS, in comparison to CT or MR when available.

Background

CEUS has proved useful in imaging abdominal organs, such as the liver and kidneys. The diverse splenic pathology is also very well presented with the use of contrast agents.

Imaging findings OR Procedure details

Basic splenic anatomy knowledge is refreshed. Pathophysiology basis of splenic abnormalities is described. The commonest pathologic conditions of the spleen are reviewed (lymphoma, metastasis, haemangioma, abscess, traumatic laceration, cyst, splenunculus, splenic hilum lymph node, infarct, pseudotumour, Echinococcus infection etc). B mode, Colour Doppler and CEUS images are presented, in correlation with CT when performed. Ultrasound contrast agents add information on the nature of the lesions, demonstrating real time perfusion in a short time with no radiation. Administering contrast for splenic imaging is an off-label indication in Europe, therefore patient’s informed consent needs to be obtained.

Anatomy

The spleen measures approximately 10-13 cm in length, 7 cm in width and 3-4 cm in thickness. It weighs about 150-200 gr and lies beneath the 9th-12th thoracic ribs, between the fundus of the stomach and the diaphragm [1]. The spleen is almost entirely surrounded by peritoneum, and held in position by two peritoneal folds: the splenophrenic ligament and the gastrosplenic ligament. It is part of the lymphatic system, possessing only efferent lymphatic vessels. The splenic artery is a branch of the celiac artery and gives branches to the stomach and pancreas before reaching the spleen. The splenic vein merges with the superior mesenteric vein to form the portal vein.

Conventional ultrasound
The spleen shows focal lesions less often than other solid organs [2]. However, its examination is an indispensable part of abdominal sonography. Benign lesions are more often than malignant [3]. US sensitivity is inferior to that of CT-MR, but improves post US contrast agent injection [4]. The commonest benign entities are cysts (simple, traumatic, haemorrhagic, Echinococcus). Less often infarcts, haemangiomas, abscesses, pseudotumours, hamartomas, parasitic and tuberculous lesions etc occur [2, 5]. The commonest malignancies are lymphoma and metastases.

On conventional US, benign lesions usually present as solitary hypoechoic findings, often with particles of gas or calcification [3, 6-8]. On the contrary, splenic malignancies are often multiple, with increased or mixed echogenicity, indiscreet borders or target-like appearance [3, 9]. These imaging criteria however are not pathognomonic [10]. Normal variants and traumatic lesions are also quite often. Finally, there are cases in which a lesion may appear to belong to the spleen, but eventually represents a hilar lymph node.

**Contrast enhanced ultrasound**

Splenic contrast enhanced ultrasonography (CEUS) is frequently used when the baseline examination is believed or shown to be inadequate for proper splenic assessment [11]. In our institution, we administer intravenously the (sulfur hexafluoride-based) contrast agent SonoVue at a 2.4-4.8 mL volume. As this is an off-label indication, the patient is asked to sign an informed consent form. Very few contraindications exist for this drug and side effects are very rare.

A very low (0.06-0.1) mechanical index is used. The sound beam is focused at the deeper aspect of the interest region. Splenic enhancement begins around 12 sec post contrast agent injection and is initially inhomogeneous, similar to the zebra pattern seen on contrast enhanced CT (CECT) (Figure 1). Initially, small arteries radiating from the splenic hilum can be observed. Venous enhancement is poor [11]. It becomes homogeneous about 50 sec post injection and lasts for 5-7 min. Enhancement is longer than the blood-pool phase, probably because of some kind of parenchymal uptake [12]. Contrary to the left kidney, which enhances in an intense but transient manner, the spleen is hypoechoic in the early phase and hyperechoic in the late phase [11].

**CEUS appearance of common splenic lesions**

- Splenic infarcts

On conventional US they appear as triangular hypoechoic lesions, base towards the capsule and point towards the hilum [4]. Post contrast injection, the same areas do not enhance [13, 14] (Figure 2).
• **Abscesses**

They are usually hypoechoic round or ovoid lesions on baseline US. After the administration of contrast agents, there is no uptake in the inner part of the lesions, while the rim and septa, if present, show some enhancement, especially on late-phase scanning *(Figure 3)*.

• **Tumours**

Small haemangiomas are usually echogenic on baseline US [13, 14]. On CEUS, they enhance in a pattern similar to the rest of the spleen *(Figure 4)*. Larger lesions show a centripetal or diffuse filling, with a dense and prolonged enhancement, sometimes with a posterior shadow present [11]. Inflammatory pseudotumours show enhancement homogeneously inferior to the rest of the spleen in all phases [15] *(Figure 5)*. Cysts show no enhancement whatsoever *(Figure 6)*.

• **Lymphoma and metastases**

Lymphoma nodules and haematogenous metastases are both isoechoic or hypoechoic on unenhanced images [13, 14]. After the administration of US contrast agents, they appear as filling defects *(Figures 7, 8)*.

• **Traumatic lesions**

Spleenic injuries appear as areas with no enhancement, especially in the late phase of enhancement. Contusions are ill-defined, slightly hypoechoic areas *(Figure 9)*, while lacerations are seen as clearly hypoechoic bands, usually perpendicular to the spleen surface [11] *(Figure 10)*. When the spleen is ruptured, there is complete architectural derangement *(Figure 11)*.

• **Accessory Spleen-Hilar Lymph node**

An accessory spleen (splenunculus) is a normal variant, showing an enhancement pattern parallel to that of the rest of the splenic parenchyma. On the contrary, a splenic hilum lymph node does not enhance in the same way *(Figure 12)*.

**Images for this section:**
**Fig. 1:** Normal spleen on B mode US (a). On CEUS, the zebra pattern is evident 40 sec post injection (b). The spleen enhances homogeneously 75 sec post injection (c).
Fig. 2: Splenic infarct on B mode US (a), CEUS (b) and CECT (c).
Fig. 3: Splenic abscesses (arrows) on B mode (a) and Power Doppler (b) US are better depicted post contrast injection (c).
**Fig. 4:** Small echogenic haemangioma on B mode US (a) enhances along with the rest of the spleen post SonoVue injection (b).
Fig. 5: A splenic pseudotumour (arrows) is barely noted on B mode and Colour Doppler US (a), as well as on CECT (b). The lesion enhances slightly less than the rest of the spleen on CEUS (c). The pseudotumour as seen post surgical removal (d, e).
**Fig. 6:** A simple splenic cyst does not enhance at all on CEUS (a) and CECT (b).
**Fig. 7:** Lymphoma. Multiple echopoor lesions on B mode US (a) are better depicted on CEUS (b, c).
**Fig. 8:** An echogenic metastasis (arrow) of the spleen is noted on B mode US (a). On CEUS (b) and CECT (c) it appears as a filling defect.
**Fig. 9:** Patient involved in a car accident. B mode US (a) and CECT (c) reveal no splenic lesion. On CEUS (b) a small contusion is noted in the hilum of the spleen.
**Fig. 10:** Splenic laceration. On B mode US (a) no lesion is seen, however fluid is noted around the spleen. Post US contrast injection (b), the laceration is evident as a filling defect. Finding confirmed by CECT (c).
**Fig. 11:** Splenic rupture. On B mode US (a) there is architectural derangement and perisplenic fluid. Post SonoVue injection (b) multiple filling defects are noted.
**Fig. 12:** Lymph node (arrows) next to the hilum of the spleen. On B mode US (a) it is similar to an accessory spleen. However, post contrast injection it does not enhance in the same way (b).
Conclusion

The addition of contrast agents improves detection and characterisation of splenic pathology. Radiologists should be familiar with CEUS technique and the examination protocol. Knowledge of a variety of pathological conditions is crucial for locating the lesion, setting a diagnosis and avoiding unnecessary imaging examinations, thus saving radiation, time and money.

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References


