Contrast Enhanced Ultrasonography for the Evaluation of Coil Embolization of Splenic Artery Aneurysm

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A 65-year-old woman with compensated liver cirrhosis secondary to hepatitis C virus infection was under surveillance for early detection of hepatocellular carcinoma with ultrasonography and, due to suboptimal ultrasound feasibility, at longer intervals with computed tomography (CT). During follow-up, a splenic artery aneurysm appeared and progressively increased from 18 mm to \( \approx 30 \) mm in diameter over a 9-month interval. The patient had severe splenomegaly secondary to portal hypertension and hypersplenism with a low platelet count (\( \approx 30,000/\text{mL} \)). Percutaneous arterial embolization was proposed to the patient because severe portal hypertension was considered a contraindication to surgical splenectomy. Embolization was carried out, preceded by platelet infusion, using “fibered” coils and interlocking detachable coils without complications.

Eight weeks later, the patient underwent abdominal CT as part of the surveillance program for hepatocellular carcinoma; no nodule with pattern of hepatocellular carcinoma was identified; at the splenic level, frank metallic artifacts were evident and prevented assessment of treatment efficacy (Figure 1) as described in previous reports from the literature.

To investigate the splenic aneurysm status, an attempt was made with conventional ultrasound (Figure 2) and color duplex-doppler ultrasonography, which failed to provide definitive and unquestionable information about the success of the embolization. Doppler ultrasound detected aneurismal arterial signals, but this mere detection does not signify unsuccessful of treatment because the lumen of the splenic artery is expected to remain at least partially patent (Figure 3). Briefly, ultrasonography was unable to demonstrate whether the lumen of the aneurismal sac had been completely obliterated or persisted patent (and at what extent) (Figures 2 and 3). Because magnetic resonance angiography was also expected to suffer from artifacts similar to those of CT, assessment of treatment efficacy would have required digital subtraction angiography, but this is an invasive procedure with additional hazards in a patient with low platelet count. For these reasons, ultrasound was immediately integrated with contrast enhancement. Contrast enhanced ultrasound (CEUS) works at second harmonic ultrasound frequency, which reduces artifacts and is able to detect flowing as well as stationary microbubbles, with a sort of subtraction of background echoes (as tissues mainly produce echoes at the fundamental frequency, which is removed). CEUS was performed with a low amount of contrast agent, injected in an antecubital vein (1 mL of SonoVue, Bracco, Milan, Italy) to limit disturbance from contrast signals deriving from surrounding vessels, namely, portosystemic collaterals at the splenic hilum. CEUS clearly showed persistent patency of the peripheral parts of the aneurysm, around the metallic coils, which instead included a thrombosed core, anechoic as devoid of any contrast perfusion (Figure 4 A and B; see also Movie I in the online-only Data Supplement). Such a pattern indicated an incomplete effect of the first embolization,
information that was not provided by the previous CT. Based on such an examination, the patient was resubmitted to arteriography, which confirmed the findings of CEUS (Figure 5) and allowed further metallic coil deployment. Follow-up examination with CEUS 2 days later confirmed complete obliteration of the aneurysm (Figure 6A) and partial splenic infarction at the upper pole due to dislodgement of a single metallic coil (Figure 6B).

The possibility of optimal assessment of coil embolization of splenic artery aneurysm was confirmed in other patients, including 1 patient who received splenic aneurysm embolization 7 years before. Also, in this case, CEUS showed a detailed evaluation of the extent of coil-induced thrombosis and size of the residual patent lumen (Figure 7).

The present images suggest that CEUS, a low-cost, noninvasive, safe technique, is worth attempting to assess arterial aneurysms treated by coil embolization. CEUS is recommended even if conventional ultrasonography appears technically unsatisfactory due to artifacts because second harmonic imaging can eliminate most of them, provided that the aneurysm can be preliminarily identified with ultrasonography. CEUS is able to show contrast distribution within the aneurysm, even in the presence of coils, and it might rescue cases in which adequate assessment of the aneurysm is prevented by artifacts at CT or magnetic resonance imaging, limiting unnecessary, especially invasive radiological techniques.

Disclosures
Fabio Piscaglia and Luigi Bolondi received consultancy fees for giving scientific lectures during events sponsored by Bracco.

References
Figure 4. A, Early arterial phase (14 seconds after contrast injection). The lumen of the aneurysm is clearly evident at CEUS, appearing as a semilunar hyperechoic structure (arrows), whereas the central area appears echofree (black) (arrowhead), corresponding to thrombosed portions, determined by coils deployment. S, spleen. The splenic parenchyma has been poorly reached by contrast at this time point and still remains black. At conventional B-mode ultrasound (showed in the left part of each panel in gray scale), no information can be obtained about patency of the lumen due to artifacts. B, Full arterial phase (24 seconds after injection). The splenic parenchyma (S) becomes perfused by contrast, whereas the signal intensity within the patent portions of the aneurysm has become greater. Splenic veins are still scarcely perfused due to the limited amount of contrast injected (1 mL of SonoVue).

Figure 5. Percutaneous angiography. A core of thrombotic material encapsulated by metallic coils can be observed within the aneurysm (black arrow). The peripheral portions of the aneurysm are still patent and perfused (asterisks). S, spleen; B, bowel; C, catheter.
Figure 6. A, CEUS 2 days after re-embolization shows absence of any perfusion within the splenic artery aneurysm (arrows). S, spleen. B, Upper portion of the spleen is nearly devoid of any contrast, indicating localized infarction due to dislodgement of a metallic coil from the aneurysm at the upper part of splenic hilum (arrowhead). S, spleen; I, infarction.

Figure 7. CEUS evaluation of thrombotic and residual patent lumen of a splenic aneurysm treated by coil embolization 5 years before in a liver transplantation patient. Left and right panels show the same image taken concurrently with and without contrast agent. Left, Conventional gray scale B-mode ultrasonography is unable to discriminate whether the lumen remained patent and at what extent. Metallic coils appear as hyperechoic structures along the outer border of the aneurysm. Right, CEUS clearly demonstrates peripheral eccentric thrombosis (semilunar anechoic structure within the left part of the aneurysm, empty arrow) determined by the coils (arrowhead), leaving a residual patent lumen of 13 mm in diameter (asterisk). S, spleen.
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Circulation. 2010;122:e451-e454
doi: 10.1161/CIRCULATIONAHA.110.955518

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