Splenic Hemangiomas

Contrast-Enhanced Sonographic Findings

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Objectives—The purpose of this study was to illustrate the baseline appearance and enhancement patterns of splenic hemangiomas on contrast-enhanced sonography.

Methods—Two experienced radiologists retrospectively reviewed by consensus baseline and contrast-enhanced sonographic examinations of 27 patients (14 women and 13 men; mean age, 58.7 years) with 27 splenic hemangiomas (mean size, 2 cm) confirmed by splenectomy, biopsy, computed tomography, and magnetic resonance imaging and follow-up.

Results—On baseline sonography, 77.8% of the lesions showed a homogeneous echo texture that was mainly hyperechoic. Color Doppler imaging did not show any signal in 81.5% of the cases. After contrast agent injection, 59.2% of the splenic hemangiomas showed different degrees of contrast enhancement in the arterial phase followed by isoenhancement in the late parenchymal phase. Among these, 2 hemangiomas showed peripheral globular enhancement in the arterial phase, followed by progressive centripetal fill-in. In 29.6% of the cases, some degree of contrast enhancement was appreciable, but the hemangiomas remained substantially hypoechoic throughout the contrast-enhanced sonographic examinations, whereas in 11.1%, the combination of contrast enhancement in the arterial phase followed by wash-out in the late parenchymal phase was evident.

Conclusions—Isoechogenicity to spleen parenchyma in all phases is the most frequent typical enhancement pattern of splenic hemangiomas observed on contrast-enhanced sonography. Nevertheless, these lesions may show atypical contrast enhancement patterns; therefore, further assessment with cross-sectional techniques is needed.

Key Words—contrast-enhanced sonography; spleen; splenic hemangioma; splenic neoplasms

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Abbreviations

CT, computed tomography; MRI, magnetic resonance imaging

Focal splenic lesions are rare, occurring with a frequency of about 0.2% on sonography.[1] Hemangiomas are the most common primary benign neoplasms of the spleen, with prevalence ranging from 0.3% to 14% at autopsy.[2–4] On gray scale sonography, a splenic hemangioma may show the typical appearance described for a liver hemangioma (a hyperechoic lesion with well-defined margins with or without posterior wall shadowing, usually without a vascular signal on color Doppler evaluation).[4,5] Nevertheless, a splenic hemangioma may have an atypical sonographic aspect, making the right diagnosis difficult.[5]

Contrast-enhanced sonography represents a substantial breakthrough in sonography, and it is being increasingly used for the evaluation of focal liver lesions.[6] The unique feature of contrast-enhanced sonography of noninvasively assessing perfusion throughout the vascular phase in real time has led to a dramatic improvement in the diagnostic accuracy of sonography for detection and characterization of focal liver lesions as well as guidance and evaluation of responses to therapeutic procedures.[7,8]

Recently, several authors have considered the spleen as one of the new promising fields of application of contrast-enhanced sonography by showing that a sulfur hexafluoride–based contrast agent produces spleen-specific enhancement that lasts longer (up to 5 minutes) than typical blood pool and liver enhancement phases.[9–11]

Hence, considering that the spleen is infrequently the primary site affected by disease and that splenic lesions are somewhat rare, the radiologist is unlikely to be as familiar with these latter lesions as with those of the liver.[12] Consequently, the aim of this study was to describe baseline sonographic appearance and contrast-enhanced sonographic patterns of splenic hemangiomas.

Materials and Methods

Patient Population

All patients gave their full informed consent before contrast-enhanced sonography, and the procedure followed was in accord with the Declaration of Helsinki.[13] Baseline and contrast-enhanced sonographic examinations of 27 patients (14 women and 13 men; age range, 28–76 years; mean, 58.7 years) referred to our institution between June 2003 and September 2011 with 27 splenic hemangiomas (size range, 0.8–10.1 cm; mean ± SD, 2 ± 2.1 cm) were retrospectively evaluated. The patients' records were retrieved from our institutional radiologic database on the basis of the following inclusion criteria: (1) the presence of at least 1 splenic hemangioma with an adequate reference standard; and (2) the presence in our picture archiving and communication system (Impax; Agfa-Gevaert, Milan, Italy) of either a baseline or a contrast-enhanced sonographic study aimed at characterizing each single lesion.

Sixteen of 27 splenic hemangiomas were discovered during sonographic examinations performed for diffuse abdominal pain (n = 13), left abdominal discomfort (n = 2) and trauma (n = 1), and the remaining 11 lesions were depicted during computed tomographic (CT) examinations performed for cancer staging (n = 10: 5 hepatocellular carcinomas, 1 gastric cancer, 1 large-bowel cancer, 1 breast cancer, 1 cervical cancer, and 1 renal cancer) or to characterize an indeterminate focal liver lesion (n = 1). Twenty-five lesions underwent imaging follow-up (range, 12–48 months; mean, 14.5 months).

Sonographic Technique

Sonographic examinations were performed by the same radiologist (>5 years of experience in conventional and contrast-enhanced sonography), who was aware of the patients' clinical histories and used an iU22 scanner (Philips Healthcare, Bothell, WA) equipped with a 5–2-MHz convex array probe and pulse inversion harmonic imaging software. The study was performed under baseline conditions, including color and power Doppler analysis, and after intravenous administration of 2.4 and 4.8 mL (in patients with a normal-sized spleen [n = 25] and splenomegaly [long axis of the spleen >130 mm; n = 2], respectively) of a sulfur hexafluoride–filled microbubble-based contrast agent (SonoVue; Bracco SpA, Milan, Italy) in a rapid bolus followed by a 5-mL sterile saline flush in the antecubital vein with a 20-gauge needle.[10,14,15]

The ultrasound beam was focused immediately below the region of interest. A low frame rate (5 Hz) and a very low mechanical index (0.05–0.09) were used. Once set, the sonographic parameters, such as the focal zone, time-gain compensation, and mechanical index, were not changed throughout the study. Each lesion was scanned for up to 5 minutes, and digital cine clips were registered 5 to 30 seconds (arterial phase), 60 to 90 seconds (intermediate parenchymal phase), and 180 to 300 seconds (late parenchymal phase) from the beginning of the contrast agent bolus injection.[10,16–18] All cine clips were digitally stored as raw data in a personal computer–based workstation connected to the ultrasound unit via a standard Ethernet link.

On-site Image Analysis

The examiner measured and located each lesion in the superior, middle, or inferior third of the spleen and subjectively evaluated the baseline findings. The following parameters were considered: (1) baseline echogenicity of the lesions with respect to the remaining splenic parenchyma, defined as hyperechoic, hypoechoic, isoechoic, and mixed; (2) echo texture of the lesions, described as homogeneous and inhomogeneous; (3) borders, considered well or poorly defined; (4) lesion contours, evaluated as smooth or lobulated depending on margins that were round or lobular; (5) the presence and type (arterial or venous) of any intralesional or peripheral flow on the baseline color and power Doppler examination; and (6) the presence of calcifications.[2]

Off-site Image Analysis

All contrast-enhanced sonographic examinations were reviewed by consensus by 2 experienced radiologists (>10 years of experience in contrast-enhanced sonography) not involved in the scanning and blinded to the clinical data and the final diagnosis. Two consecutive interpretation sessions with a 7-day interval to avoid recall bias were held to complete the review process of all patients' contrast-enhanced sonographic examinations. The readers assessed the contrast enhancement behavior of each lesion in comparison with adjacent spleen parenchyma after SonoVue injection. Changes in the echogenicity and enhancement patterns after contrast medium injection, subjectively categorized as follows: (1) peripheral globular (enhancing peripheral nodular areas); (2) rimlike (continuous ring of peripheral enhancement); (3) hyperechoic (higher echogenicity than the spleen); (4) hypoechoic (lower echogenicity than the spleen); and (5) isoechoic (similar echogenicity relative to the spleen). The progression of contrast enhancement (centripetal or centrifugal) was also considered. In particular, at retrospective off-site analysis, the readers were asked to identify a splenic hemangioma on the basis of the following criteria: (1) a constantly homogeneously isoenhancing lesion; and (2) a peripheral globular pattern followed by progressive centripetal fill-in.[10,17]

Reference Standard

The final diagnosis was obtained by means of contrast-enhanced multidetector computed tomography (n = 17), magnetic resonance imaging (MRI; n = 13), biopsy (n = 2), and splenectomy (n = 2). Four patients underwent splenectomy and biopsy, respectively, within 1 week after contrast-enhanced sonography.

Strict imaging criteria, comparable with those described for liver hemangioma, were used, including the following: (1) nodular peripheral enhancement followed by centripetal fill-in; (2) isoattenuation to blood vessels; (3) high signal intensity on T2-weighted MR images; (4) homogeneous enhancement on delayed MR images; and (5) lack of a 6- to 12-month increase in size.[2–4,17,19–25]

Multidetector CT studies were performed using a 64-row multidetector scanner (Brilliance; Royal Philips Electronics, Eindhoven, the Netherlands), acquiring images before and after the administration of 1.5-mL/kg iomeprol (400 mgI/mL; Iomeron; Bracco SpA) at a flow rate of 4 mL/s by an automated power injector. The examination was performed using a bolus-tracking technique, and 3 scans were performed with delays of 20 to 25 seconds (arterial phase), 45 to 50 seconds (venous phase), and 180 to 300 seconds (delayed phase). Further late phases were acquired if necessary.

Magnetic resonance examinations were performed with a 1.5-T scanner (Signa Excite; GE Healthcare, Milwaukee, WI). The protocol included a precontrast axial T1-weighted gradient echo sequence, a T2-weighted single-shot fast spin echo sequence, a T2-weighted fast spin echo sequence, an unenhanced and contrast-enhanced T1-weighted volumetric sequences. A dynamic study was obtained after intravenous administration of a bolus of 0.2-mL/kg gadobenate dimeglumine (MultiHance; Bracco SpA) injected at a flow rate of 2 mL/s followed by 20 mL of a sterile saline solution using an automated injector. Images were acquired using an automated bolus detection technique during the arterial (14 seconds after bolus detection), venous (50 seconds), equilibrium (3 minutes), and late (5–20 minutes) phases.

Multidetector CT and MR images were evaluated using the Impax picture archiving and communication system. The interval between contrast-enhanced sonography and CT/MRI was 1 week at the latest for each patient.

Statistical Analysis

Statistical analysis was performed by a biostatistician involved in the study design using a computer software package (Intercooled Stata for Windows, version 9.2; StataCorp, College Station, TX). The association between a typical or an atypical pattern on contrast-enhanced sonography and the size (≤3 and >3 cm), baseline echogenicity (hypoechoic, isoechoic, hypoechoic, or mixed), and echo texture (homogeneous or inhomogeneous) on gray scale sonography was evaluated. To assess the association between categorical variables, the χ^2 test or Fisher exact test was used as appropriate. Statistical significance was considered to be present at $P < .05$.

Results

On-site Image Analysis

Table 1 summarizes the general and baseline sonographic features of the 27 splenic hemangiomas, located in the superior (n = 8), middle (n = 8), or inferior (n = 9) third of the spleen. Furthermore, 1 lesion involved both the superior and middle thirds of the spleen, and the last 1 involved almost the whole spleen parenchyma.

On baseline sonography, 21 of the 27 hemangiomas (77.8%) showed a homogeneous echo texture, hyperechoic (n = 15), hypoechoic (n = 4), and isoechoic (n = 2), whereas 6 (22.2%) had an inhomogeneous echo texture with a mixed appearance (n = 2, 1 of which had intralesional anechoic areas of a few millimeters) or mainly hypoechoic (n = 3) and hyperechoic (n = 1). Calcifications

Table 1. General and Baseline Sonographic Features of 27 Splenic Hemangiomas

Lesion	Size, cm	Location	Echo Texture	Borders	Contour	Echogenicity	Color Doppler	Pulsed Doppler	Reference Standard	Follow-up, mo
1	3	Superior third	Inhomogeneous	Well-defined	Round	Mixed	Peripheral	Venous	Biopsy	12
2	1	Inferior third	Inhomogeneous	Well-defined	Round	Hypoechoic	No	NA	CT	24
3	8	Superior-middle third	Homogeneous	Well-defined	Round	Isoechoic	Intralesional/peripheral	Arterial	Histology	NA
4	10.1	Whole spleen	Homogeneous	Well-defined	Round	Hyperechoic	Intralesional/peripheral	Arterial/venous	Histology	NA
5	2.8	Inferior third	Inhomogeneous	Well-defined	Round	Hypoechoic	Intralesional	Arterial	CT	24
6	0.8	Inferior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	12
7	0.9	Inferior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT/MRI	13
8	1	Inferior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT/MRI	15
9	1.1	Inferior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	15
10	1.3	Superior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	13
11	1.5	Inferior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT/MRI	12
12	1.8	Superior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	12
13	1	Inferior third	Homogeneous	Well-defined	Round	Hypoechoic	No	NA	CT	15
14	2.9	Superior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT/MRI	48
15	1.8	Superior third	Inhomogeneous	Well-defined	Round	Hypoechoic	No	NA	CT/MRI	12
16	1	Inferior third	Homogeneous	Well-defined	Round	Hypoechoic	Peripheral	Arterial	CT/MRI	13
17	1.2	Middle third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT/MRI	12
18	2.5	Middle third	Inhomogeneous	Poorly defined	Round	Mixed	No	NA	MRI	12
19	0.9	Middle third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	12
20	1.2	Superior third	Homogeneous	Well-defined	Round	Hypoechoic	No	NA	MRI	12
21	1	Middle third	Inhomogeneous	Well-defined	Round	Hyperechoic	No	NA	MRI	12
22	1.8	Middle third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	Biopsy	12
23	2	Superior third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	MRI	48
24	1.4	Middle third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	MRI	12
25	1	Middle third	Homogeneous	Well-defined	Round	Hypoechoic	No	NA	MRI	12
26	1.3	Superior third	Homogeneous	Well-defined	Round	Isoechoic	No	NA	CT	15
27	1	Middle third	Homogeneous	Well-defined	Round	Hyperechoic	No	NA	CT	12

CT indicates computed tomography; MRI, magnetic resonance imaging; and NA, not applicable.

were not observed within any hemangioma. All of the hemangiomas showed round contours, and 26 (96.3%) had well-defined borders. Color Doppler evaluation did not show any signal in 22 (81.5%) of the hemangiomas. Two had perilesional vascular signals with arterial (n = 1) or venous flow (n = 1) on pulsed Doppler analysis. In 2 cases (7.4%), both perilesional and intralesional vascular signals with arterial (n = 1) and arterial-venous (n = 1) flow were observed and, finally, the remaining case (3.8%) had intralesional arterial flow.

Off-site Image Analysis

Table 2 summarizes the contrast-enhanced sonographic patterns of the splenic hemangiomas. After contrast agent injection, 16 of 27 hemangiomas (59.2%) showed different degrees of contrast enhancement (isoechoic, hyperechoic, and peripheral globular patterns) in the arterial phase followed by isoenhancement relative to splenic parenchyma in the late parenchymal phase. Among these, 2 (7.4%)

Table 2. Analysis of Contrast Enhancement Patterns of 27 Splenic Hemangiomas After SonoVue Administration

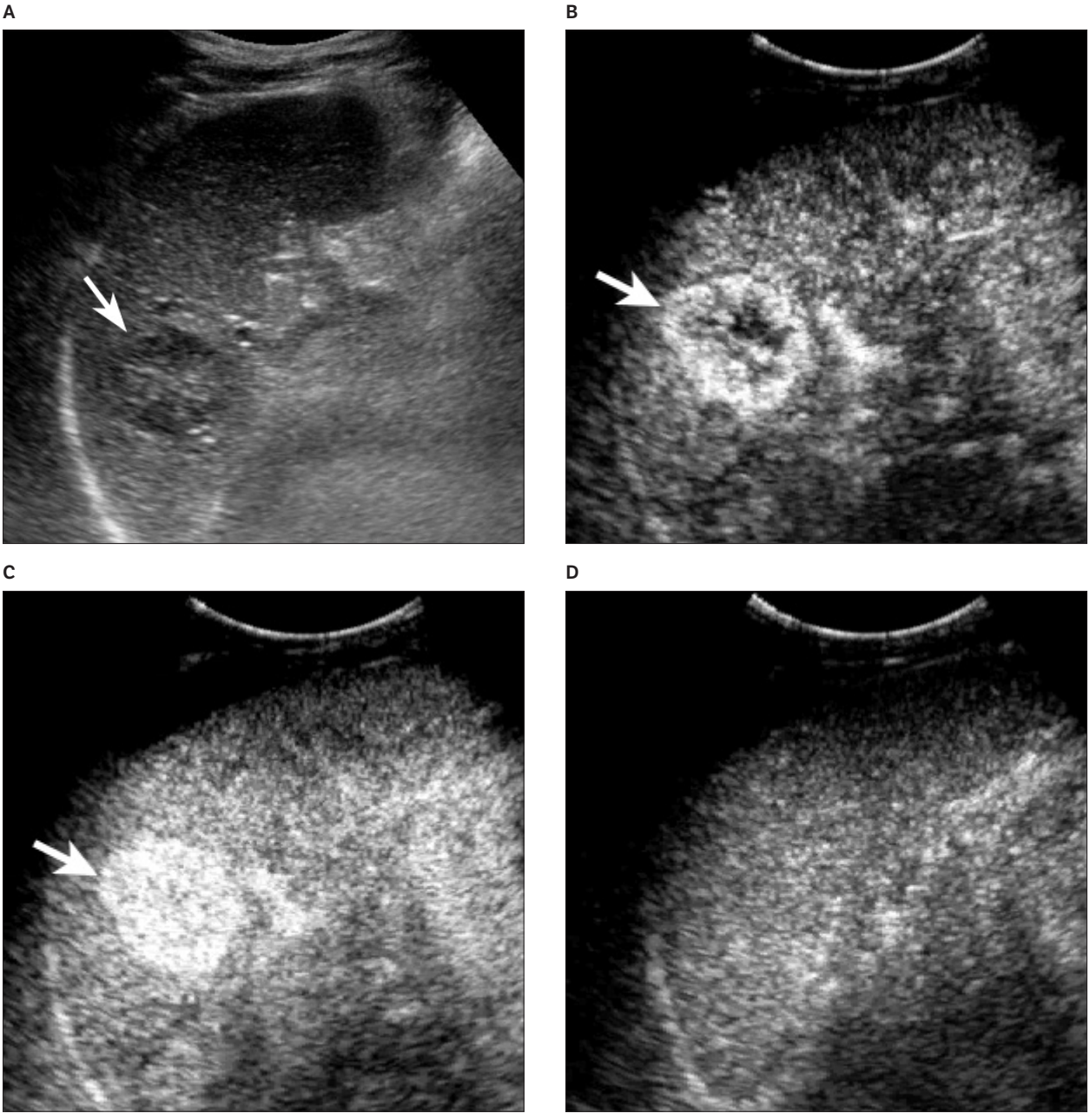
Lesions, n	Size, cm	Arterial Phase	Intermediate Parenchymal Phase	Late Parenchymal Phase
9	0.8–1.8 (1.2)	Isoechoic	Isoechoic	Isoechoic
1	3.0	Nodular peripheral	Centripetal fill-in	Complete fill-in
1	1.0	Nodular peripheral	Centripetal fill-in	Incomplete fill-in
2	1.3–8.0 (4.6)	Hyperechoic	Isoechoic	Isoechoic
1	10.5	Hyperechoic	Hyperechoic	Isoechoic
2	1–1.4 (1.2)	Hypoechoic	Isoechoic	Isoechoic
8	0.9–2.9 (1.6)	Hypoechoic	Hypoechoic	Hypoechoic
1	1.8	Hyperechoic	Isoechoic	Hypoechoic
1	1.0	Isoechoic	Hypoechoic	Hypoechoic
1	2.8	Hyperechoic	Hypoechoic	Hypoechoic

Values are range (mean) where applicable.

showed peripheral globular enhancement in the arterial phase, followed by progressive centripetal fill-in, which was complete in 1 of 2 cases (Figure 1).

Eight of the 27 hemangiomas (29.6%) showed some degree of contrast enhancement but remained substantially hypoechoic throughout the contrast-enhanced sonographic examinations (Figure 2), whereas 3 (11.1%) showed a combination of contrast enhancement in the arterial phase followed by wash-out in the late parenchymal phase (Figure 3).

Figure 1. Splenic hemangioma in a 68-year-old man with hepatocellular carcinoma. **A**, Oblique left subcostal baseline image showing a lesion with a mixed echo texture measuring 3 cm in the superior third (arrow). **B–D**, Fifteen seconds after SonoVue injection, the lesion shows peripheral globular enhancement (**B**, arrow) followed by progressive and complete centripetal fill-in at 40 seconds (**C**, arrow), becoming isoechoic with respect to the surrounding splenic parenchyma in the late phase (**D**).

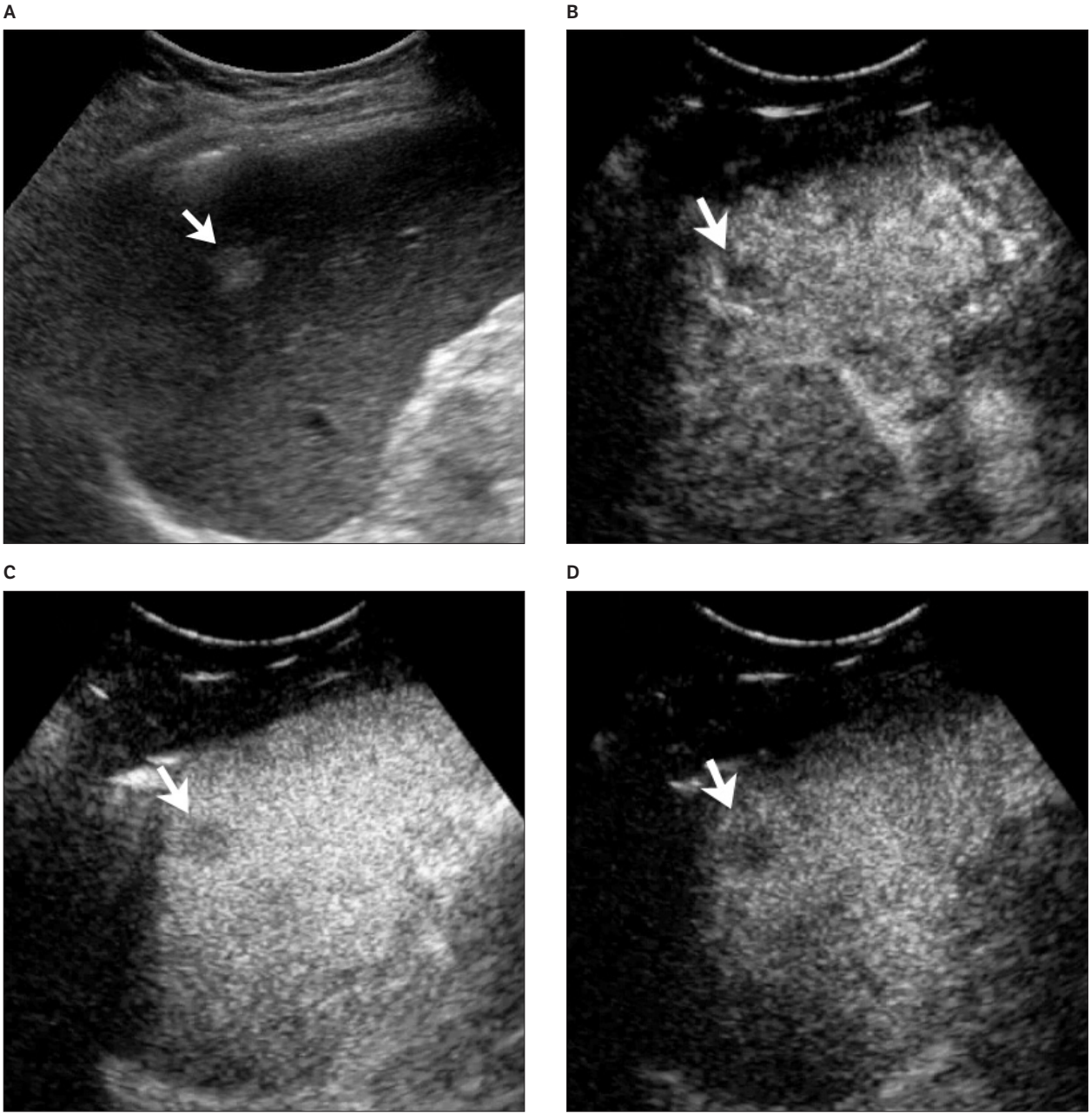


Statistical analysis showed no significant association between the contrast-enhanced sonographic pattern and size ($P = .497$), echo texture ($P > .99$), or echogenicity ($P = .851$).

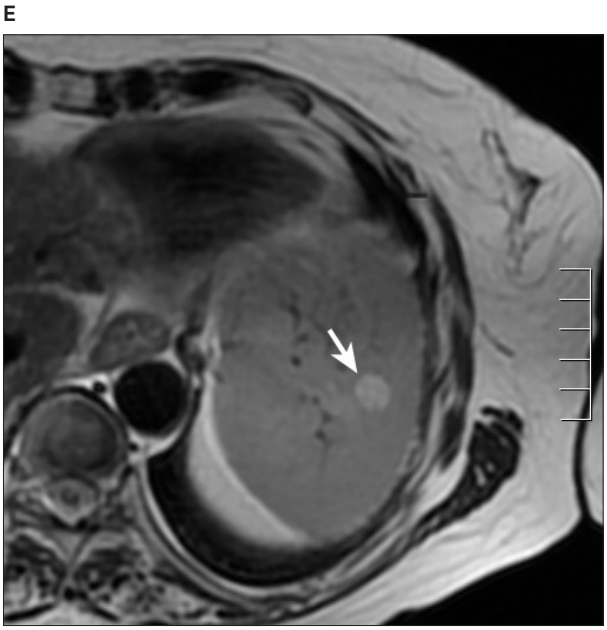
Discussion

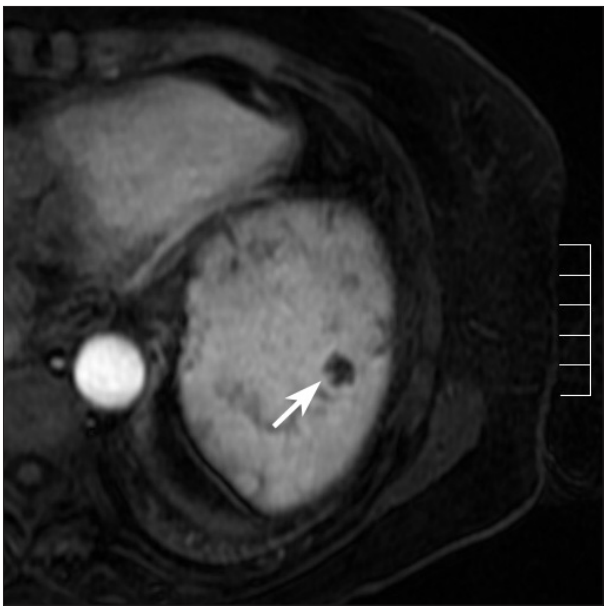
Hemangiomas are the most common benign neoplasms of the spleen, but although they are found in up to 14% of patients in autopsy series, they are less frequently detected on imaging examinations.[3] Usually, this vascular neoplasm

Figure 2. Splenic hemangioma in a 73-year-old woman with hepatocellular carcinoma. **A**, Oblique left subcostal baseline image showing a homogeneously hyperechoic lesion measuring 1 cm in the middle third (arrow). **B–D**, After SonoVue injection, the lesion appears constantly hypovascular during all phases (arrows) (continued).



is depicted in adults aged 30 to 50 years with equal frequency among men and women.[4] Splenic hemangiomas present as single or multiple masses and may be part of generalized angiomatosis as Gorham disease, Klippel-Trènaunay-Weber syndrome, Sturge-Weber syndrome, and Von Hippel-Lindau disease.[19,26] Although most splenic hemangiomas is asymptomatic, anemia, thrombocytopenia, and coagulopathy could be associated with large lesions, likely secondary to sequestration of red blood cells and platelets and consumption of clotting factors.[27] Rarely, the clinical presentation can also be acute because of spontaneous splenic rupture with consequent hemoperitoneum.[3] However, splenic hemangiomas are often discovered in asymptomatic patients as incidental findings during abdominal imaging procedures performed for other reasons, as occurred in our series.[4]





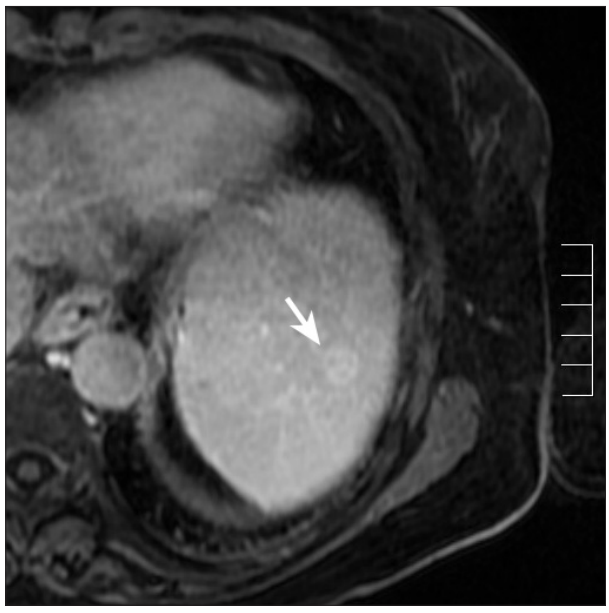
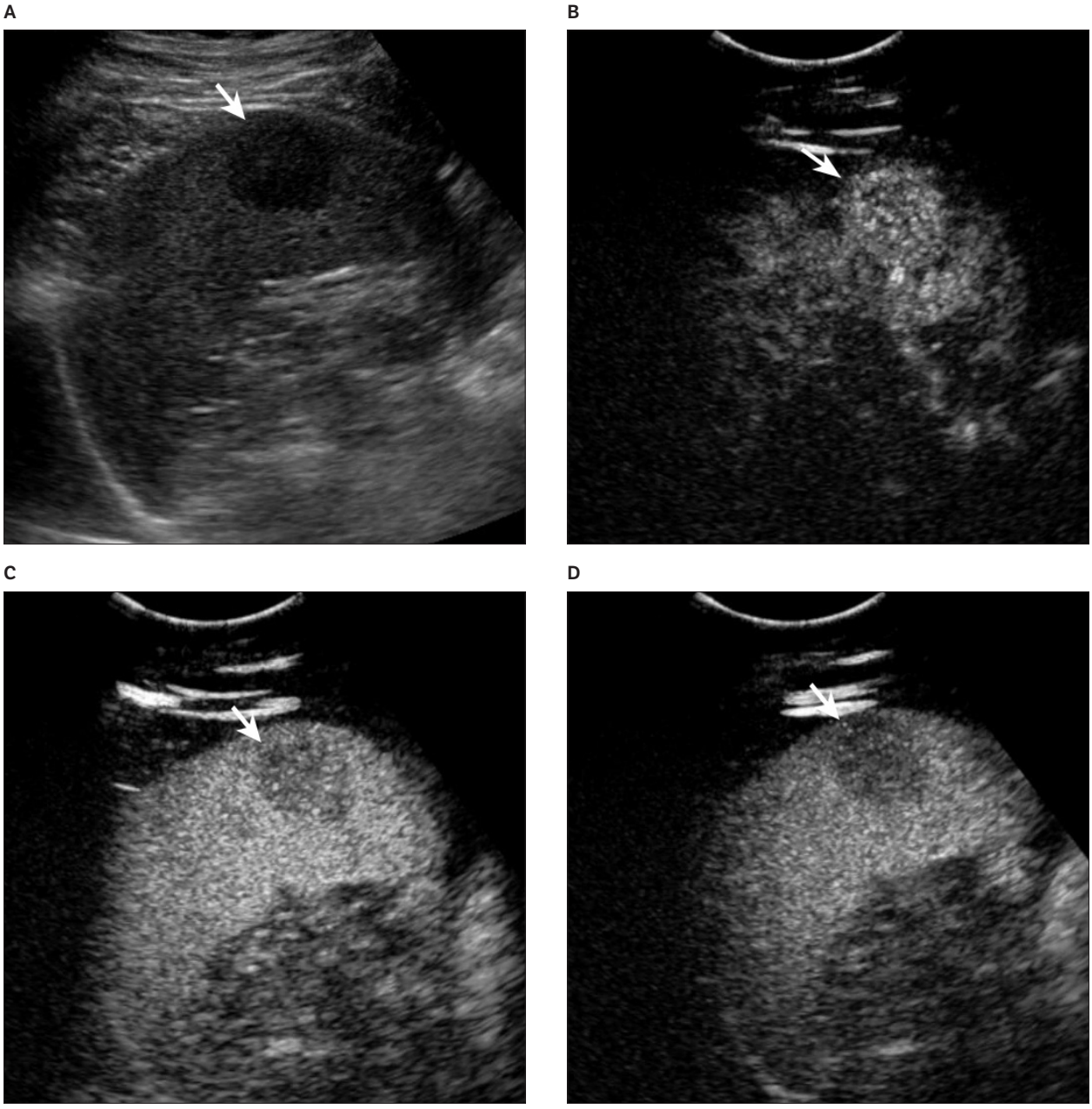


Figure 2. (continued) **E**, T2-weighted axial fast spin echo image showing a homogeneously hyperintense round lesion (arrow). **F** and **G**, On contrast-enhanced magnetic resonance imaging obtained in the arterial phase, the lesion is hypointense (**F**, arrow) but shows complete fill-in 10 minutes after contrast medium injection (**G**, arrow).

On sonography, a splenic hemangioma may appear either as a well-defined hyperechoic lesion, usually smaller than 2 cm and corresponding to the solid form, or as a large complex mass, intrasplenic or pedunculate, containing solid and cystic areas filled with serous or hemorrhagic fluid due to necrosis.[4] Nevertheless, the variability of sonographic appearances of splenic hemangiomas is reported to be greater than in the liver.[12] Furthermore, sonographic appearances of spleen disease are rather nonspecific, and differentiation between benign and malignant lesions is

Figure 3. Splenic hemangioma in a 28-year-old man found during a sonographic examination performed for trauma. **A**, Oblique left subcostal baseline image showing a homogeneously hypoechoic lesion measuring 2.8 cm in the inferior third. **B–D**, Thirty seconds after SonoVue injection, the lesion presents as hypervascular (**B**, arrow) but appears hypovascular with respect to the surrounding splenic parenchyma in both the intermediate (**C**) and late (**D**) phases.



often difficult. The latter are more likely multifocal or diffuse, characterized by rapid growth and the presence of extrasplenic abdominal masses.[12,28] In our series, on gray scale sonography, less than two-thirds of splenic hemangiomas showed a typical hyperechoic appearance with well-defined borders, suggesting the diagnosis of a hemangioma, whereas the remaining 12 (44.4%) were otherwise undetermined.[5]

According to previously published data reporting that in most splenic hemangiomas, the vascularization is poor on color Doppler evaluation, in our series, 22 of the 27 hemangiomas (81.5%) did not show any vascular signal, confirming that the practical utility of color Doppler imaging in characterizing splenic lesions is quite low.[1,18] However, the absence of major intralesional vessels may be helpful in differentiating splenic hemangiomas either from malignant lesions, such as lymphomas and metastasis, and other benign masses, such as hamartomas, in which color Doppler sonography usually depicts a hypervascular pattern.[4,17] Contrast-enhanced sonography represents a reliable, safe, and cost-saving technique with diagnostic accuracy similar to that of CT and MRI performed with state-of-the-art scanners in the characterization of focal liver lesions.[29] In particular, a sulfur hexafluoride–based contrast agent might not be necessarily a pure vascular agent, as initially deemed, because it seems to have a marked spleen-specific uptake, maybe in the reticuloendothelial system or sinusoids. Therefore, spleen enhancement after SonoVue injection lasts longer than liver enhancement, usually greater than 5 minutes.[11,30]

In our experience, after SonoVue administration, 11 of the 27 splenic hemangiomas (40.7%) showed contrast enhancement patterns suggestive of hemangiomas.[10,31] In particular, the most frequent enhancement pattern of the splenic hemangiomas depicted on contrast-enhanced sonography was isoechogenicity to spleen parenchyma in all phases (one-third of all splenic hemangiomas). This pattern is different from the typical contrast enhancement pattern of liver hemangiomas but is considered diagnostic of splenic hemangiomas.[10,31] Only 2 splenic hemangiomas showed the well-known peripheral globular enhancement followed by progressive centripetal fill-in.

This latter pattern is peculiar but less frequently observed in splenic hemangiomas than in liver hemangiomas.[15,19] In fact, Stang et al[17] never observed this contrast enhancement behavior in their study population including 26 splenic hemangiomas, whereas von Herbay et al[16] depicted it in 2 of their 3 splenic hemangiomas. Interestingly, 5 other splenic hemangiomas showed sustained contrast enhancement in the late parenchymal phase, a pattern suggesting benignity. By contrast, 11 of the 27 splenic hemangiomas (40.7%) in our series showed a hypovascular appearance in the late parenchymal phase on contrast-enhanced sonography, 3 of which showed late wash-out. This finding is quite unusual, although it has also been reported in liver hemangiomas, suggests malignity, and, hence, may be confounding for the radiologist.[17,32] Our study confirms that even in the spleen, this contrast enhancement pattern is not always suggestive of malignancy.[32] In this regard, von Herbay et al,[16] comparing benign and malignant spleen lesions on contrast-enhanced sonography, confirmed that a persistent hypoechoic aspect in both the early and parenchymal phases was highly suspicious of benign lesions, and we observed this behavior in about one-third of our cases.

In this latter case, a further imaging technique may be mandatory for lesion characterization.[4] Actually, CT and MRI showed complete fill-in in all 11 splenic hemangiomas in our study presenting on contrast-enhanced sonography as hypoechoic masses in the late parenchymal phase (as shown in Figure 2). Some hypotheses can be made to explain this already reported atypical behavior.[18,33] First, as in the liver, splenic hemangiomas may contain large vascular channels and, consequently, internal slow flow. Hence, the ability to observe progressive and complete fill-in may require even longer than 15 minutes, and CT and MRI best suited for this purpose, probably because of the longer half-life of the contrast media.[34] Second, the spleen is a highly vascularized organ, and on contrast-enhanced sonography, even vascular lesions may appear hypoechoic with respect to the surrounding splenic parenchyma. Finally, as already reported, SonoVue shows high spleen-specific enhancement because it seems to accumulate within the reticuloendothelial system with prolonged enhancement of parenchyma. The absence of reticuloendothelial cells within the hemangioma could explain the difference in contrast enhancement between the latter and the normal splenic parenchyma. However, in our study, statistical analysis showed no significant association between the enhancement pattern on contrast-enhanced sonography, either typical or atypical, and size, echo texture, or echogenicity.

Our study had some limitations. First, the final diagnosis was established by histologic evaluation in only 4 cases. However, considering ethical reasons and according to literature, the diagnosis of a splenic hemangioma can be confidently obtained when clinical, biochemical, and imaging criteria are met, recommending follow-up of patients with asymptomatic splenic hemangiomas at least until the lesions are determined to be of a constant size,

and the lesions included in our study did not show any size changes during follow-up.[2,3,35–37] Second, off-site imaging analysis was performed by consensus, and interobserver agreement was not assessable. Finally, our study population was limited, but that factor can be justified by the rarity of the lesions.

In conclusion, in our experience, isoechogenicity to spleen parenchyma in all phases is the most frequent typical enhancement pattern of splenic hemangiomas on contrast-enhanced sonography. Nevertheless, these lesions may show atypical contrast enhancement patterns more frequently than their liver counterparts. When a splenic mass is discovered during a sonographic examination performed for other reasons, in the absence of a clinical history suggesting a malignant nature, a primary benign vascular neoplasm should be considered, and a hemangioma is the most common focal splenic lesion. Contrast-enhanced sonography can be considered an effective tool for the diagnosis only when showing typical contrast enhancement patterns. Otherwise, further assessment with cross-sectional techniques is needed for characterization.

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