Gd-EOB-DTPA enhanced MR imaging of small hepatic hemangioma (<1cm)

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Purpose

Gadolinium-ethoxybenzyl (Gd-EOB)-DTPA is an alternative hepatobiliary contrast agent that allows combined dynamic imaging and hepatocyte-specific imaging in a single examination. Gd-EOB-DTPA can be injected as a bolus and shows the enhancement characteristics and variety of liver lesions. Several reports have shown that liver tumors can be reliably detected at a high rate using hepatobiliary contrast agents. However, no investigations have focused on the detection of small hepatic hemangiomas (<1cm) with Gd-EOB-DTPA, which are often difficult to distinguish from malignant tumors such as liver metastases and hepatocellular carcinoma.

The purpose of this study is to clarify the contrast enhancement features of small hepatic hemangiomas (<1cm) on Gd-EOB-DTPA enhanced MR imaging and to evaluate the usefulness of Gd-EOB-DTPA in the diagnosis of small hepatic hemangiomas.
Methods and Materials

Patients

Eighteen patients (8 men, 10 women) with 34 small hepatic hemangiomas (range 4 to 9mm; median 6mm) were selected for this study according to the following criteria: a) the size of the hemangioma was less than 1cm in diameter; b) the patient had undergone contrast enhanced CT before or after dynamic MR imaging; and the hemangioma showed a typical enhancement pattern on CT imaging (globular peripheral enhancement and/or rapid homogeneous enhancement).

MR imaging

All MR imaging was performed on a 1.5T MR system (Magnetom Avanto; Siemens Healthcare, Erlangen, Germany) with a phased-array surface multicoil for signal reception. Patients were scanned before and after contrast administration. To avoid contrast timing mismatch during Gd-EOB-DTPA enhanced dynamic MR imaging, TWIST (time-resolved angiography with stochastic trajectories) sequence with high time resolution was selected. Axial breath-hold T1-weighted TWIST images were acquired with a TR of 2.74 ms, TE of 1.08 ms, 25° flip angle (FA), slice thickness of 3 mm, pixel bandwidth of 590 Hz/pixel, field of view of 350 mm, field of view phase 71.9%, slice per slab 52, slice oversampling 23.1%, resolution 256x256, slice resolution 63%, slice partial Fourier 7/8, phase partial Fourier 6/8, central region A 35%, sampling density B 40%, and grappa pat factor 2. The whole liver was anatomically covered before IV administration of Gd-EOB-DTPA. Dynamic imaging was started immediately following bolus injection of Gd-EOB-DTPA and repeated 11 times consecutively, with 5 seconds between each acquisition. The T1-weighted gradient-recalled-echo sequence as hepatobiliary phase was repeated 20 minutes after the Gd-EOB-DTPA injection.

Contrast agent

Gd-EOB-DTPA (gadolinium-ethoxybenzyl-diethylenetriamine-pentaacetic acid, Primovist®, Bayer Schering Pharma, Berlin, Germany) is a paramagnetic hepatobiliary contrast agent with hepatocellular uptake via the anionic-transporter protein. All patients received an IV dose of 25 mmol Gd-EOB-DTPA/kg body weight. Gd-EOB-DTPA was administered intravenously as a bolus at a rate of 2-3 ml/s that was flushed with 10 ml saline.

Image analysis

All images were interpreted and assessed for the character of contrast enhancement, and the presence or absence of typical enhancement of hemangioma such as globed
peripheral enhancement and/or rapid homogeneous enhancement. The enhancement characteristics over time were assessed for peripheral and central enhancement patterns during the dynamic phase and during the hepatobiliary phase. Two experienced radiologists evaluated the patterns of signal intensity change of small hepatic hemangiomas on unenhanced and Gd-EOB-DTPA enhanced T1-weighted TWIST images, as compared with the patterns on the CT images.
Results

On dynamic enhanced CT images, all cases showed a typical enhancement pattern such as peripheral nodular enhancement (14/34) and rapidly homogeneous enhancement (20/34). On the other hand, on Gd-EOB-DTPA enhanced dynamic MR images, in 26 of 34 (76%), typical enhancement patterns such as peripheral nodular enhancement (7/26) and rapidly homogeneous enhancement (19/26) were seen. The remaining 8 of 34 (24%) cases showed no enhancement at all in the dynamic phase.

Graph 1 on page 6 shows a comparison between the CT and MRI dynamic patterns. Eighteen of 20 (90%) rapidly-enhanced hemangiomas on dynamic CT images presented a similar rapid homogeneous enhancement pattern on dynamic MRI (Fig. 1 on page 6). On the other hand, 6/14 (43%) globular enhanced hemangiomas on dynamic CT presented a globular enhanced pattern on dynamic MRI (Fig. 2 on page 7), while the remaining 7 of 14 (50%) hemangiomas showed atypical findings such as no enhancement at all in the MR dynamic phase, despite showing typical enhancement on contrast enhanced CT (Fig. 3 on page 8). All hemangiomas showed a low signal intensity in the hepatobiliary phase.
Fig. 0: Eighteen of 20 (90%) rapidly-enhanced hemangiomas on dynamic CT images presented a similar rapid homogeneous enhancement pattern on dynamic MRI. On the other hand, 6/14 (43%) globular enhanced hemangiomas on dynamic CT presented a globular enhanced pattern on dynamic MRI, while the remaining 7 of 14 (50%) hemangiomas showed atypical findings such as no enhancement at all in the MR dynamic phase, despite showing typical enhancement on contrast enhanced CT. All hemangiomas showed a low signal intensity in the hepatobiliary phase.

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**Fig. 0:** Fig. 1; Dynamic CT shows a rapid homogeneous enhancement pattern in a small hepatic hemangioma. This hemangioma shows hyperintensity on T2WI. EOB-enhanced dynamic MRI also shows rapid homogeneous enhancement, and hepatobiliary phase T1WI shows a hypointense area. The dynamic CT pattern corresponds to the EOB-enhanced dynamic MR pattern.

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Fig. 0: Fig. 2; Dynamic CT shows a globular enhancement pattern in a small hepatic hemangioma. This hemangioma shows hyperintensity on T2WI. EOB-enhanced dynamic MRI also shows similar globular enhancement, and hepatobiliary phase T1WI shows a hypointense area. The dynamic CT pattern corresponds to the EOB-enhanced dynamic MR pattern.

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Fig. 0: Fig. 3; Dynamic CT shows a globular enhancement pattern in a small hepatic hemangioma. This hemangioma shows hyperintensity on T2WI. EOB-enhanced dynamic MRI shows no enhancement, and hepatobiliary phase T1WI shows a hypointense area. The dynamic CT pattern does not correspond to the EOB-enhanced dynamic MR pattern.

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Conclusion

Our study results demonstrate that many small hepatic hemangiomas with typical dynamic patterns on CT images show atypical dynamic patterns on Gd-EOB-DTPA dynamic MR images.

Hemangiomas can be diagnosed on the basis of their typical pattern of enhancement in the dynamic phase. Rapid T1-weighted MR imaging with paramagnetic extracellular MR contrast agents allows an assessment of tumor vascularity, with these agents exhibiting enhancement of hemangiomas on delayed images, which is a useful sign for tumor characterization.

Gd-EOB-DTPA is a newly developed hepatobiliary contrast agent that exhibits high T1 relativity in the liver. Combined dynamic imaging and hepatocyte-specific imaging with Gd-EOB-DTPA allow us to make an accurate qualitative and quantitative diagnosis. Enhancement during the distribution phase of contrast agents depends mainly on tumor vascularity and its blood supply, whereas enhancement on delayed images is characterized by the cell specificity of MR contrast agents.

The higher relativity of Gd-EOB-DTPA compensates in part for the lower gadolinium concentration, 0.25mol/L, in its currently approved formulation; in comparison, gadolinium chelates is 0.5mol/L. The recommended dose, 0.025mmol/kg body weight, is also lower than the dose of standard Gd chelates, 0.1mmol/kg body weight. Because of the lower dose, the bolus volume with Gd-EOB-DTPA will be only half the volume of extracellular agents. This underlines the need for more exact bolus timing, especially of the arterial phase.

It has been reported that at the time of liver-specific imaging, hemangiomas do not take up hepatobiliary contrast agents and extracellular pooling has vanished. Small hemangiomas without typical enhancement may be difficult to differentiate from other liver tumors, such as metastasis, because only an intermediate signal intensity on T2WI and the liver-specific phase of hepatobiliary agents are not helpful because neither a metastasis nor hemangioma should exhibit specific uptake of the contrast agent. In our study, it was difficult to diagnosis small hepatic hemangiomas, especially with tiny enhancement such as globular peripheral enhanced hemangiomas, based on the Gd-EOB-DTPA enhancement patterns in spite of using a high time resolution sequence, although rapid type enhanced hemangiomas could be diagnosed by multi-dynamic MR. In such cases, an additional dynamic study using extracellular contrast agents such as Gd-DTPA and iodine may be required.

Our study has several limitations. First, the images were reviewed retrospectively. Second, the hemangiomas were not histopathologically proven. Third, contrast enhanced CT was not performed on the same day as the dynamic MRI.
In conclusion, it may be difficult to diagnose small hepatic hemangiomas (<1cm) by using the enhancement pattern on Gd-EOB-DTPA enhanced MR imaging because some of them, especially globular peripheral enhanced ones, show no enhancement.
References


