Enhancement characteristics of liver hemangioma in comparison with dynamic gadoxetic acid-enhanced MRI and dynamic contrast-enhanced CT

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Authors: S. Kobayashi¹, M. Honda², H. Sugimoto¹; ¹Shimotsuke/JP, ²Utsunomiya/JP
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Purpose

• Liver hemangioma is the most common liver benign tumor, second to metastasis in whole liver tumors, and its incidence is estimated 1-4% in general population.

• Histologically, large vascular channels filled with slowly circulating blood with lining single layer of mature flattened endothelial cells separated by thin fibrous sept.

• Liver hemangioma has various enhancement patterns on contrast-enhanced computed tomography (CT) and magnetic resonance imaging (MRI). In most cases, dynamic contrast-enhanced CT and/or MR imaging with using extracellular contrast material show peripheral enhancement in early phase and gradual centripetal fill-in in delayed phase. However, contrast enhancement patterns of liver hemangioma show different due to its size and/or internal architecture such as fibrosis, thrombosis, and hemorrhage. Especially, small liver hemangioma often shows rapid homogeneous enhancement in early phase and wash-out in delayed phase, thus, differentiation between liver hemangioma and hypervascular malignant lesion including hepatocellular carcinoma or metastasis is sometimes difficult when patient has risk factor or primary malignant lesion.

• Recently, several liver-specific contrast materials for MRI have been developed and those clinical usefulness has been reported by many researchers for detection and/or characterization of liver lesions.

• Gadolinium ethoxybenzyl diethylenetriaminepentaacetic acid (gadoxetic acid disodium, Gd-EOB-DTPA) is one of those liver-specific contrast materials and it distributes not only extracellular space, but also hepatocyte due to absorption of membraneous transporter.

• This bimodal contrast material enables lesion detection and combined evaluation of perfusion and hepatocyte-specific properties simultaneously in one examination, and it contributes increasing diagnostic performance of liver MR imaging.

• On the other hand, diagnosis of liver hemangioma is now challenging on MRI with use of Gd-EOB-DTPA.

• Because contrast-enhancement patterns of liver hemangioma show various types, and in comparison CT or MRI with use of extracellular contrast material, there are several weaker points such as narrow optimal time window to obtain appropriate images during arterial dominant phase due to injection of smaller amount of contrast material, faster wash-out of contrast material from lesion, depiction of almost all lesions as low signal intensity in hepatocellular phase, which results in difficulty to distinguish liver hemangioma from other liver lesions.

• When evaluating liver lesion including liver hemangioma on MRI, T2-weighted image (T2WI) plays an important role because liver hemangioma shows very high signal
intensity similar to liver cyst. However, on T2WI, liver hemangioma sometimes shows intermediate intensity due to partial volume effect and/or internal architecture, thus, diagnosis for liver hemangioma is not able to establish even though combination of T2WI and use of Gd-EOB-DTPA on MRI.

• As far as we could explore, no previous report has assessed the relationship of enhancement pattern between dynamic contrast-enhanced MRI with use of Gd-EOB-DTPA (EOB-MRI) and dynamic contrast-enhanced CT (D-CT).

• Thus, the purpose of this retrospective study was to investigate enhancement characteristics of liver hemangioma in comparison with EOB-MRI and D-CT.
Methods and Materials

• Patients selection
  
  • Between December 2008 and May 2009, 44 patients who were suspected of liver hemangiomas on EOB-MRI were identified in our radiological reporting system.
  
  • Among them, 18 patients were excluded because eight patients were established other diagnoses and eight patients did not perform D-CT.
  
  • In the remaining 26 patients, five lesions in three patients were not detected on D-CT, and one lesion in one patient was revealed partial data deficiency of EOB-MRI, so that these six lesions were excluded from analysis.
  
  • Finally, a total number of 33 liver hemangiomas in 24 patients (17 male and 7 female, age range of 41 to 76 years, mean age of 64.9 years) were enrolled in this study.

• Imaging Protocols

1. EOB-MRI
  
  • MRI was performed with a 1.5-T superconductive system (MAGNETOM Avanto, a Tim system, Siemens, Erlangen, Germany) with body matrix coils.
  
  • Axial breath-hold dynamic 3D-VIBE images with chemically selective fat suppression were obtained before and at 30 seconds and 1, 3, 10, and 20 minutes after intravenous bolus injection of 0.025-mmol/kg Gd-EOB-DTPA with a 20-ml saline flash. All injections were performed at a speed of 1 mL/sec by using a power injector.
  
  • Scan parameters were as follows: TR/TE =4.3/1.5 msec, flip angle = 15#, field of view = 2.5-3 mm, matrix = 256 x 120-140, slice thickness = 2.5-4 mm.

2. Biphasic dynamic contrast-enhanced CT
  
  • Biphasic dynamic contrast-enhanced CT (16-row MDCT, Sensation, Siemens, Erlangen, Germany or 64-row MDCT, Definition, Siemens, Erlangen, Germany) images were obtained before and at 30 and 100 seconds after intravenous bolus injection of 100-mL nonionic iodinated contrast material. All injections were performed at a rate of 3 mL/sec with a power injector.
  
  • Scan parameters were as follows: tube voltage = 120 kV, tube current = auto, slice thickness = 7mm.

• Image Analysis
All DICOM data were transferred to Macintosh personal computer (Mac OS version 10.5.8) and image analysis was performed by using DICOM viewer (OsiriX version 3.7).

- Measurement of lesion maximum diameter: On 20-minute image of EOB-MRI, lesion maximum diameter was measured by caliper.
- Analysis of enhancement characteristics

A. Measurement of lesion signal intensity or density

- On EOB-MRI or D-CT, lesion signal intensity or density at each phase were measured respectively by drawing circular ROIs with including lesions as large as possible.

B. Definitions of enhancement characteristics

- EOB-MRI: Peak phase was defined as lesion showed the highest signal intensity after injection of contrast material.
- D-CT: Patterns of lesion density changes between 30- and 100-second images were classified such as (a) peak; density decreased more than 10%, (b) persistent; increased more than 10%, (c) plateau; within ±10%.
Images for this section:

**Fig. 0:** This image shows how to draw ROI (orange circle) for lesions.

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Results

• Lesion maximum diameter
  • Overall (N = 33): mean, 11.35 ± 4.71 (SD) mm; range, 3.6 - 25.2 mm
  • < 10 mm (N = 16): 7.51 ± 1.66 mm; range, 3.6 - 9.2 mm
  • ≥ 10 mm (N = 17): 14.96 ± 3.63 mm; range, 10.3 - 25.2 mm
**Fig. 0:** This image shows how to draw ROI (orange circle) for lesions.

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**Results**

- Enhancement characteristics of D-CT and EOB-MRI (Lesion maximum diameter < 10 mm)

**Fig. 0:** Enhancement characteristics of D-CT and EOB-MRI (Lesion maximum diameter < 10 mm)

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**Results**

- Enhancement characteristics of D-CT and EOB-MRI (Lesion maximum diameter ≥ 10 mm)

**Fig. 0:** Enhancement characteristics of D-CT and EOB-MRI (Lesion maximum diameter ≥ 10 mm)

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### Results

**Fig. 0**: Relationship of enhancement characteristics between EOB-MRI and D-CT according to lesion maximum diameter

<table>
<thead>
<tr>
<th>Lesion maximum diameter</th>
<th>&lt; 10 mm (N = 16)</th>
<th>≥ 10 mm (N = 17)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-CT</td>
<td>Peak or Plateau</td>
<td>Persistent</td>
</tr>
<tr>
<td>EOB-MRI</td>
<td>6 (37.5)</td>
<td>10 (62.5)</td>
</tr>
<tr>
<td>30 sec</td>
<td>3 (18.8)</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>1 min</td>
<td>2 (12.5)</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>3 min</td>
<td>1 (6.3)</td>
<td>6 (37.5)</td>
</tr>
<tr>
<td>10 min</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>20 min</td>
<td>0 (0)</td>
<td>1 (6.3)</td>
</tr>
</tbody>
</table>

Numbers in parentheses represent percent.

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**Fig. 0**: Lesion maximum diameter is 9.2 mm. On D-CT, enhancement of the lesion shows peak pattern. On EOB-MRI, the lesion shows T2 hyperintensity and enhancement peak is seen at 30 sec.

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Fig. 0: Lesion maximum diameter is 16.1 mm. On D-CT, enhancement of the lesion shows persistent pattern. On EOB-MRI, the lesion shows T2 hyperintensity and enhancement peak is seen at 3 min.

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Conclusion

• In conclusion, liver hemangioma in maximum diameter less than 10 mm and peak or persistent pattern on dynamic contrast-enhanced CT tended to form earlier enhancement peak on EOB-MRI compared to others.
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