HCC-TO-LIVER CONTRAST ON ARTERIAL-DOMINANT PHASE IMAGES OF EOB-ENHANCED MRI: COMPARISON WITH DYNAMIC CT AND CTHA

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Introduction: The evaluation of arterial blood supply in tumor is an essential step for both diagnosis and management of hepatocellular carcinoma (HCC) .A recently available liver-specific contrast medium, gadolinium- EOB, reportedly has a high diagnostic capability for detection of malignant liver tumors. However, its diagnostic capability for HCC is reportedly only slightly better or equal to that of dynamic CT. Possible reasons for this are that the administrated volume of EOB is smaller than that of extracellular gadolinium contrast media and its concentration of gadolinium is only about half. Therefore, HCC-to-liver contrast can be assumed to be lower on arterial phase images of EOB-enhanced MRI than that on arterial phase images of dynamic CT or MRI using extracellular gadolinium contrast media, thus resulting in a lower detection rate of HCC and lower ability to assess hypervascularity. However, no objective studies dealing with this issue have been reported. The purpose of this study was to assess the efficacy of arterial-dominant phase images of Gd-EOB-DTPA-enhanced MRI for evaluation of arterial blood supply in HCC in comparison with that of multiphasic dynamic CT and CT during hepatic arteriography (CTHA).

Materials and methods: This study comprised 30 patients (22 men and 8 women, mean age: 68.0 years) with 40 pathologically proven HCCs (well differentiated: 3, moderately differentiated: 30, poorly differentiated: 7; mean diameter: 45.1 mm), all of whom underwent EOB-enhanced MRI, dynamic CT, and CTHA for preoperative assessment within one month. EOB- MRI was performed with a superconducting imager operating at 1.5 T. A multiphasic dual-arterial dynamic study was performed using three-dimensional T1-weighted gradient-echo (TR/TE/FA: 2.25-3.09/0.8-1.5 /10-15; matrix: 224 × 168; FOV: 380 - 400 mm; 1 NEX; slice thickness: 8 mm; transverse slices: 22-30; SPIR; parallel imaging factor: 2.0; scan time: 7 sec) with bolus IV of 25μmol/kg of Gd-EOB-DTPA by a power injector at a rate of 2 ml/s, followed by 30 ml of saline chaser at the same rate during breath holding. The scan delays were set at 20 seconds after the start of injection and dual-arterial dynamic images were obtained serially during a single breathhold. Dynamic CT was performed by using 64-detector row CT systems. Each subject was first examined with unenhanced CT, and this was followed by the injection of iodinated contrast medium with a power injector. Injection dose was 600 mg iodine per kg of BW and duration was fixed at 25 seconds. CTHA were performed with the aid of an interventional CT unit. Catheter angiography was performed via the right femoral artery with the Seldinger technique and a 3 or 4-Fr catheter. Prior to CTHA, CTAP and the selective celiac and common hepatic arteriograms were obtained. A total of 65-75 ml of iodinated contrast medium at a concentration of 300 mgI/ml was used for these procedures. Dual-phasic CTHA was performed via the common hepatic artery during breathholding with the injection of 20–30 ml of iodated contrast medium (diluted with saline to 100 mgI/ml) at a rate of 2-3 ml/s with a power injector with the following parameters: 5mm thk axial slices, 0.5 - 0.75 s/gantry rot, 120 kVp, 240 - 440 mA. Scanning delays were 10 and 30 seconds after the start of injection. Two experienced abdominal radiologists were asked to select the images with HCCs shown at their maximal diameter. Then, they were also asked to select the phase with the higher HCC-to-liver contrast from the first and second arterial-dominant phase images of dynamic CT and EOB-enhanced MRI and from the first and second phase images of CTHA for each patient. The selected phases and images were then used for further analyses. The quantitative analysis was conducted by the observers on the images obtained with all the examinations using the operator-defined ROI measurements of mean signal intensity or CT value of HCC and surrounding normal liver parenchyma. The oval ROI was placed within HCC and made as large as possible to include necrotic areas and the visually selected maximal enhancement area (5 to 10% of the total tumor area). The ROI for surrounding normal liver parenchyma was at least 5 cm^2 and located adjacent to the target lesion, while vessels were avoided as much as possible. The ROIs were placed in the same locations among all the examinations as far as possible. Figure 1 shows examples of ROI placements. HCC-to-liver contrasts (Michelson's contrast: $C_M = (S_{HCC} - S_{Liver})/ (S_{HCC} + S_{Liver})$) were calculated and compared among the modalities. HCC-to-liver contrasts were also visually scored on a 5-point scale (1: signal intensities or CT values of HCC are lower than those of surrounding normal liver, 5: signal intensities or CT values of HCC are markedly higher than those of surrounding normal liver) and compared.

Results: HCC-to-liver contrasts were visually higher on the second arterial-dominant phase images of both EOB-enhanced MRI and dynamic CT for all patients, so that only these images were used for further analyses. On the other hand, since HCC-to-liver contrasts were visually higher on the first phase images of CTHA, only these images were used for further analyses.-For one observer, the mean C_M of CTHA was significantly higher than that of EOB-enhanced MRI ($p<0.05$) (Table 1).For both observers, the mean maximal C_Ms of dynamic CT were significantly higher than those of EOB-enhanced MRI ($p <0.005$ and <0.05). For one observer, the mean maximal C_M of CTHA was significantly higher than that of EOB-enhanced MRI ($p <0.05$) (Table 2). Finally, for both observers the mean visual scores of dynamic CT and CTHA were significantly higher than those of EOB-enhanced MRI ($p < 0.001$, < 0.05, <0.0005, <0.05) (Table 3). The κ values for the two observers were 0.80 for dynamic CT, 0.80 for EOB-enhanced MRI, 0.74 for the CTHA, indicating that substantial to almost perfect agreements were obtained.

Conclusion: Dynamic CT and CTHA are more suitable modalities than EOB-enhanced MRI for evaluation of arterial blood supply in HCC. This should be taken into account for diagnosis and management of HCC.

Table 1. Mean HCC-to-liver contrasts for the three modalities

	Dynamic CT	EOB-MRI	CTHA
Observer 1	0.19 ± 0.11	0.13 ± 0.13	0.20 ± 0.15*
Observer 2	0.19 ± 0.10	0.13 ± 0.14	0.18 ± 0.19

*P<0.05

Table 2. Mean maximal HCC-to-liver contrasts for the three modalities

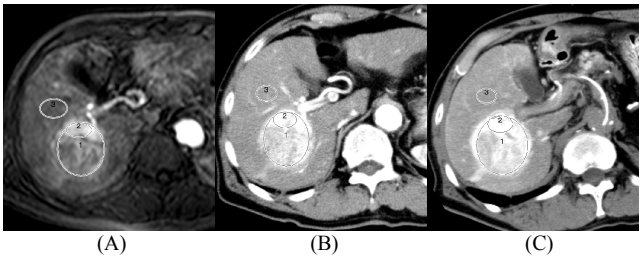
	Dynamic CT	EOB-MRI	CTHA
Observer 1	0.29 ± 0.10**	0.19 ± 0.12	0.27 ± 0.16*
Observer 2	0.30 ± 0.09*	0.20 ± 0.14	0.25 ± 0.21

*P<0.05, **P<0.005

Table 3. Mean visual scores for HCC-to-liver contrasts for the three modalities

	Dynamic CT	EOB-MRI	CTHA
Observer 1	3.5 ± 1.1***	2.5 ± 0.9	3.2 ± 1.4*
Observer 2	3.7 ± 1.1****	2.6 ± 1.0	3.2 ± 1.3*

*P<0.05, ***P< 0.001, ****P< 0.0005



(A) (B) (C)

Fig. 1. A 78-year-old man with hepatocellular carcinoma (HCC) in the right posterior segment.

Second arterial-dominant phase image of EOB-enhanced MRI (A) shows heterogeneous and slight enhancement of the lesion. The visual score was 3. Second arterial-dominant phase image of contrast-enhanced dynamic CT (B) and first phase image of CT during hepatic arteriography (CTHA) (C) demonstrate heterogeneous and noticeable enhancement of the lesion. The visual score was 4 for both images.

The regions-of-interest (ROI) were placed within HCC and made as large as possible to include necrotic areas, the visually selected maximal enhancement area, and the surrounding normal liver parenchyma. Signal intensity and CT value were measured and HCC-to-liver contrasts calculated.

The latter were 0.20 for EOB-enhanced MRI, 0.29 for dynamic CT, and 0.29 for CTHA. Maximal HCC-to-liver contrasts were also calculated and were 0.33 for EOB-enhanced MRI, 0.37 for dynamic CT, and 0.37 for CTHA.