Relation between Child-Pugh score and liver parenchymal contrast ratio on hepatobiliary phase images using Gd-EOB-DTPA-enhanced MR imaging

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Aims and objectives

Hepatobiliary phase (HBP) of Gd-EOB-DTPA (EOB) -enhanced MRI enable us to depict most of the hepatic neoplasms since normal hepatic hepatocytes uptake EOB and abnormal lesions do not uptake EOB. However, some of the cases do not show good parenchymal EOB uptake and difficult to depict hepatic lesions as hypointense lesion on HBP images.

A recent publication reported a correlation between Child-Pugh (C-P) "class" and liver parenchymal enhancement on HBP. However, there are few reports about the relationship between C-P "score" and the degree of enhancement of liver parenchyma on HBP.

The purpose of this study was to clarify the relationship between C-P score and liver parenchymal enhancement on HBP images of EOB-enhanced MRI.
Methods and materials

From January 2013 to December 2013, 646 consecutive patients underwent EOB-enhanced MRI for detection or characterization of focal liver tumors. Among the 646 patients, 207 were excluded for the following reasons: (1) no blood examination within 1 week before or after MR imaging, (2) positive vascular involvement (Vp>Vv) on imaging. Positive vascular involvement may have adversely affected our evaluation of the MR imaging signal intensity. Thus, the remaining 439 patients (268 men and 171 women) with a mean age of 66.8 years (range: 5-88 years) were included in our study.

The underlying liver diseases were as follows: hepatitis B (n=71), hepatitis C (n=173), alcohol (n=47), hepatitis B+C (n=7), hepatitis B+alcohol (n=3), hepatitis C+alcohol (n=7), liver metastasis (n=73), non-alcoholic steatohepatitis (n=16), cholangiocellular carcinoma (n=8), primary biliary cirrhosis (n=3), autoimmune hepatitis (n=3), Caroli disease (n=1), focal nodular hyperplasia (n=1), idiopathic portal hypertension (n=1), hepatoblastoma (n=1), hepatic amyloidosis (n=1), liver injury (n=9), cirrhosis of unknown etiology (n=14).

The numbers of patients with a C-P score of 5 to 15 were as follows: 247, 79, 54, 34, 16, 7, 3, 3, 0, 0, and 1, respectively.

EOB-enhanced MR images were obtained with either a 1.5-T (n=156) or 3.0-T (n=283) MR system (Signa HDx; GE Medical Systems, Milwaukee, Wis) by using the same protocol. MR imaging was performed with a fat-suppressed three-dimensional T1-weighted spoiled gradient echo in the steady state sequence (liver acquisition with volume acceleration extended version, generalized encoding matrix; repetition time msec/echo time msec, 3.4-3.6/1.6; flip angle, 12°-15°; field of view, 42x42 cm; matrix, 192x320 interpolated to 512x512; section thickness, 4.2 mm; and overlap, 2.1 mm). For the dynamic study, a dose of 0.1 mL of Primovist (0.25 mmol/mL of gadoxetic acid, Bayer Schering Pharma, Berlin, Germany) per kilogram of body weight was intravenously injected at a flow rate of 1.0 mL/sec, followed by a 30-mL saline flush.

We used the test injection method (1.5 mL of gadoxetic acid plus an 8-mL saline flush) to determine the optimal arterial dominant phase, which was determined as the peak time of enhancement in the abdominal aorta plus an additional 10 seconds of imaging time (16-22 seconds) - 1#2. After imaging in the arterial phase, portal phase and equilibrium phase images were obtained 20 and 60 seconds after the previous imaging phase was finished, respectively. The hepatobiliary phase image were obtained 20 minutes after the injection of EOB in all patients.
The signal intensities (SI) of the liver and intrahepatic vessel were measured on HBP images, and the ratio of the signals was calculated in terms of the hepatic vascular/parenchymal contrast ratio (HCR). The regions of interest (ROI) were manually placed in the left main portal vein, adjacent liver parenchyma, inferior vena cava (IVC) and adjacent liver parenchyma of the caudate lobe in a same axial image by one radiologist. The equation used for the calculation is as follows: (1) HCR of PV = SI of the left main portal vein/SI of adjacent liver parenchyma of the left lobe, (2) HCR of IVC = SI of the left main portal vein/SI of adjacent liver parenchyma of the caudate lobe, (3) $HCR_{ave} = \frac{HCR$ of PV + HCR of IVC}{2}$

We used the Steel-Dwass and Spearman's rank correlation coefficient to compare $HCR_{ave}$ with C-P class and C-P score. A p-value <0.05 was considered statistically significant.
**Table 1: Patient characteristics**

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Fig. 1: Hepatic vascular/parenchymal contrast ratio (HCR)

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Fig. 2: Example of Hepatic vascular/parenchymal contrast ratio (HCR) and imaging findings

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Results

The HCR_{ave} was significantly lower in patients with C-P class A than in patients with C-P class B and C ($p < 0.01$).

A significant positive correlation was observed between HCR_{ave} and C-P score ($r_s=0.53$, $p <0.01$).

The percentage of patients with a C-P score of 5 to 9 who have as poor HCR_{ave} as those with high C-P score were as follows: 0.4, 3.6, 3.5, 5.3 and 30.8, respectively.
Fig. 3: Relation between HCR and C-P class. The mean values of HCR were significantly lower in patients with C-P class A than in patients with C-P class B and C# Steel-Dwass ** p #0.01

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Fig. 4: Relation between HCR and C-P score. A significant positive correlation was observed between HCR and C-P score. Spearman’s rank Correlation Coefficient $rs=0.53\#p<0.01$

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Fig. 5: Some patients with low C-P score have as poor HCR as those with high C-P score#
Fig. 6: Example no.1 of poor HCR on HBP images with low C-P score HCR=1.081
69yo Female chronic hepatitis B T.bil 1.6, Alb 3.3, PT 75%, no ascites, no encephalopathy
C-P score A#6)

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**Fig. 7:** Example no.2 of poor HCR on HBP images with low C-P score HCR=0.928 54yo Male chronic hepatitis B T.bil 1.3, Alb 4.6, PT 95%, no ascites, no encephalopathy C-P score A#5)

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Conclusion

Inadequate liver parenchymal enhancement on HBP of EOB-enhanced MR imaging tend to impair detection or characterization of focal liver lesions. It might be important to identify the factors affecting the degree of liver enhancement in advance, not only to avoid non-diagnostic or insufficient examinations but to increase cost-effectiveness and practice throughput.

We demonstrated that HCR increased significantly in patients with C-P B and C compared to those with C-P A. Recently, a few clinical studies have reported the degree of liver enhancement on HBP of EOB-enhanced MRI are assumed to depend on the degree of liver function. Although, some studies have handled liver-spleen contrast ratio for evaluation of enhancement degree of HBP images of EOB-enhanced MR imaging, we have evaluated the ratio of liver parenchyma and intrahepatic large vessels in this study. The advantage of our method is applicable to the patients with splenectomy. Some of the cirrhotic patients might have resected spleen to control portal hypertension. Even in such cases, we can evaluate the degree of parenchymal enhancement of HBP-EOB-MRI with the use of vessels as reference. Actually, in this cohort, there are 27 patients with splenectomy.

A positive correlation between the C-P score and HCR of HBP images on EOB-enhanced MRI was observed ($r_s = 0.53$). 4% of patients with C-P A showed poor HCR on HBP images, which might be the reason of not so strong correlation between the C-P score and $HCR_{ave}$. The possible causes of poor images in CP A cases might be the drug-drug interaction mechanism (combined use of EOB and other drugs might suppress the membranous transporter activity) and/or genetic polymorphism but details of the mechanisms remain unknown. Further studies are needed.

This study has several limitations. First, C-P scoring system include subjective clinical parameter. Some studies have reported with MELD/MELD-Na score. But in routine clinical practice, MELD/MELD-Na score have been not yet widely available, and we have been familiar with C-P scoring. Second, the number of patients with high C-P score is so small. Patients with high C-P score have less opportunity to undergo EOB-enhanced MRI than patients with low C-P score, because, usually such patients are not the target for therapeutic intervention.

In conclusion, a positive correlation between the C-P score and HCR of HBP images were observed on EOB-enhanced MRI. We need to clarify what kind of factors might influence poor EOB uptake on HBP images in patients with low C-P score.
References


