Characterization of Hyperintense Nodules on Precontrast T1-weighted MR Imaging: The Utility of Gadoxetic Acid-Enhanced Hepatocyte-Phase Imaging

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Introduction

T1-weighted (T1W) hyperintense nodules against a background of cirrhosis are diagnostically challenging in clinical practice. Differentiation of T1W hyperintense nodule into benign or malignant nodule is a challenging task without histopathological examination in patient with cirrhotic liver. Since hepatic resection or transplantation is the most effective treatment for HCC if the diagnosis is made at an early stage and can change the prognosis drastically, accurate preoperative imaging for the characterization of dysplastic nodule from HCC becomes crucial. American Association for the Study of Liver Diseases (AASLD) practice guidelines for the management of HCC indicate that HCC can be confidently diagnosed if dynamic imaging shows a typical vascular pattern with arterial enhancement followed by portal venous "washout". However, determination of contrast enhancement is not always easy to accomplish for T1W hyperintense lesions in arterial phase during dynamic imaging.

Gadoxetic acid is a liver-specific MR imaging contrast medium with combined perfusion and hepatocyte-selective properties. Gadoxetic acid produces high tissue contrast and has been shown significantly to improve the detection of focal liver lesion compared with unenhanced MR, with enhanced MR using conventional agents and with contrast-enhanced CT. Diagnostic performance of gadoxetic acid for characterization T1W hyperintense nodule within cirrhotic liver has not been evaluated previously. The purpose of the present study was to evaluate the utility of gadoxetic acid-enhanced hepatocyte-phase MRI in characterization of T1W hyperintense nodules within cirrhotic liver.

Materials and Methods

From May, 2007 to Apr, 2010, 42 patients with focal hepatic lesions, having undergone gadoxetic acid-enhanced MR imaging and received histopathological examination were reviewed. The inclusion criteria for the present study were: a) The nodule which underwent histological examination should present hyperintense on T1W in-phase imaging; b) The time interval between initial MR study and histological examination should be less than one month. Finally, 19 patients with 34 nodules were enrolled in the present study. The evaluation of standard of reference revealed 15 dysplastic nodules (DN), seven well-differentiated HCCs (wHCC), and 12 moderately differentiated HCCs (mHCC). Precontrast pulse sequences including dual echo T1WI, T1W with fat saturation imaging (FS-T1WI) were performed. All patients received a 0.025 mmol/kg dose of gadoxetic acid. An equilibrium-phase FS-T1WI was performed at 180 s. The T2WI and T2WI with FS were undertaken immediately after the equilibrium-phase FS-T1WI was completed. Twenty minutes after contrast agent injection, FS-T1WI and 3D T1WI with the same parameters as precontrast pulse sequences were obtained. All images were reviewed retrospectively by two radiologists. Signal intensity on dual echo T1WI, T2WI as well as enhancement patterns on dynamic images and hepatocyte-phase imaging were recorded. The reviewers used the following criteria for characterization of the T1W hyperintense nodules. Conventional HCC diagnostic criteria: first, hyperintense on T2WI/FS-T2WI; second, arterial enhancement followed by contrast washout on the dynamic MR images. Additional to the conventional criteria, a nodule presenting with hypointense on 20-min delayed hepatocyte-phase imaging was also considered as a HCC. Statistical analysis were performed to the differences between conventional HCC diagnostic criteria and hepatocyte-phase imaging, tumor size between the dysplasia and HCC.

Results

The pathology, tumor size, signal intensity on precontrast T1WI/T2WI of the 34 T1W hyperintense nodules are shown in Table 1. The mean size of dysplastic nodules was smaller than HCCs (p<0.001). With ROC analysis, tumor size was a important factor in characterization of T1W hyperintense nodule. When size threshold was determined at 1.6 cm, the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were 89.5%, 73.3%, 81% and 84.6%, respectively.

Enhancing patterns on gadoxetic acid-enhanced MR imaging of the 34 T1W hyperintense nodules are shown in Table 2. None of 15 DNs depicted arterial enhancement during dynamic study or hypointense on hepatocyte-phase imaging. There were five mHCCs and six wHCCs showed atypical HCC-enhancing profile in dynamic study. In contrast to dynamic study, only one wHCC showed atypical presentation with hyperintense in the hepatocyte-phase imaging. There were seven additional HCCs diagnosed using hepatocyte-phase imaging compared to conventional HCC diagnostic criteria (Fig. 1). The diagnostic performance of hepatocyte-phase was superior to conventional criteria alone in characterization of T1W hyperintense nodule (p=0.02).

Table 1. The pathology, tumor size, signal intensity on precontrast T1WI and T2WI of the 34 T1-weighted hyperintense nodules are shown.

Pathology	Tumor Number	Tumor Size (cm)	T1WI			T2WI		
			In-phase	Opposed-phase				
			Hyper	Hyper	Hypo	Hypo	Iso	Hyper
DN	15	1.5±0.3	15	15	0	13	2	0
HCC	19	2.8±1.2						
wHCC	7	2.2±0.9	7	3	4	6	1	0
mHCC	12	3.1±1.3	12	12	0	3	2	7

DN, dysplastic nodule; HCC, hepatocellular carcinoma; wHCC, well-differentiated HCC; mHCC, moderately differentiated HCC; Hyper, hyperintense, Iso, isointense; Hypo, Hypointense; SD, standard deviation; T1WI, T1-weighted imaging; T2WI, T2-weighted imaging

Table 2. The enhancing patterns on gadoxetic acid-enhanced MR imaging of the 34 T1-weighted hyperintense nodules are shown.

Pathology	Tumor Number	Dynamic study				Hepatocyte-phase imaging		
		Arterial enhancement		Washout				
		+	-	+	-	Hypo	Iso	Hyper
DN	15	0	15	0	15	0	4	11
HCC	19							
wHCC	7	2	5	4	3	6	0	1
mHCC	12	9	3	7	5	12	0	0

DN, dysplastic nodule; HCC, hepatocellular carcinoma; wHCC, well-differentiated HCC; mHCC, moderately differentiated HCC; Hyper, hyperintense, Iso, isointense; Hypo, Hypointense

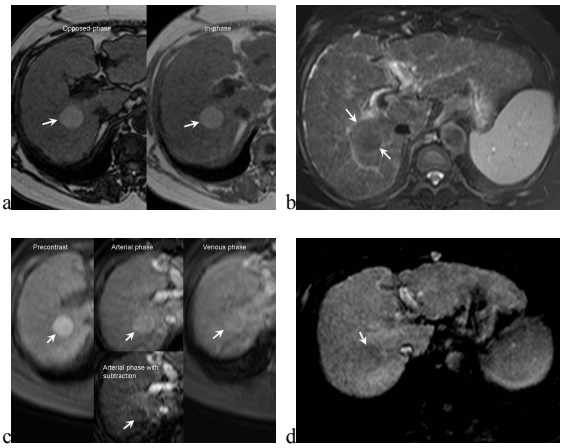

Figure 1. A 57-year-old female with a well-differentiated HCC (arrow) at segment 8 of the liver underwent gadoxetic acid-enhanced MR imaging and liver biopsy. a) The tumor depicted hyperintense on both opposed-phase and in-phase T1-weighted imaging. b) The tumor showed isointense to hypointense on T2-weighted with fat suppression imaging. c) The tumor showed no obvious enhancement on arterial phase and no contrast washout on venous phase of the dynamic 3D-T1-weighted imaging. No obvious arterial enhancement of the tumor in the arterial phase with subtraction imaging is found. d) The HCC showed hypointense on the hepatocyte-phase T1-weighted with fat suppression imaging.

Conclusion

Gadoxetic acid-enhanced MRI with hepatocyte-phase is superior to gadoxetic acid-enhanced MRI with conventional criteria alone in characterization of T1W hyperintense nodule. Gadoxetic acid-enhanced MRI with hepatocyte-phase should be considered first in characterization of T1W hyperintense nodule. T1W hyperintense nodule of >1.6 cm size within cirrhotic liver depicting hypointense on gadoxetic acid-enhanced hepatocyte-phase imaging should be treated aggressively.