Differentiation of T1W hyperintense nodules among cirrhotic liver: Comparison of ferucarbotran-enhanced MR imaging with accumulation phase FS-T1WI and gadolinium-enhanced MR imaging

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Introduction

T1-weighted (T1W) hyperintense nodules against a background of cirrhosis are diagnostically challenging in daily practice. All regenerative nodules, dysplastic nodules and HCC might present hyperintense on T1W imaging, so T1W hyperintense nodules cannot be definitively characterized as dysplastic nodules or HCC before biopsy, resection or transplantation. Positive arterial enhancement during dynamic MR imaging is a well-known criterion in diagnosis of HCC. However, determination of contrast enhancement is not always easy to accomplish for T1W hyperintense lesions in arterial phase during dynamic imaging using conventional Gadolinium-base contrast agent. SPIO-enhanced MR imaging reflects Kupffer-cell numbers in HCCs and is useful for estimation of histological grading in HCCs. We hypothesized that ferucarbotran-enhanced MR imaging might be superior to gadolinium-enhanced MR imaging in characterization of T1W hyperintense nodules within cirrhotic liver. The purpose of our study was to evaluate the ferucarbotran-enhanced MR imaging with accumulation-phase fat suppression T1-weighted imaging in comparison with gadolinium-enhanced MR imaging for characterization of T1W hyperintense nodules within cirrhotic liver.

Materials and Methods

Two separate groups of patients with histologically proven T1-weighted (T1W) hyperintense nodule on MR imaging were retrospectively identified. The ferucarbotran group consisted of 17 T1W hyperintense nodules in 12 patients. The gadolinium group consisted of 22 T1W hyperintense nodules in 21 patients. All of the patients had liver cirrhosis. Finally, 11 HCC nodules, and 6 benign nodules were included in the ferucarbotran group; 15 HCC nodules and 7 benign nodules were included in the gadolinium group. The signal intensity on T2WI/T1WI as well as enhancement patterns of the corresponding lesions on contrast-enhanced dynamic images was also recorded. The presence of arterial enhancement of the lesion was detected by automatically subtraction of dynamic study using the software of MR machine. The reviewers used the following criteria for diagnosis of the T1W hyperintense nodules as HCC: first, a nodule presented hyperintense on the precontrast T2WI or presence of early arterial enhancement during dynamic MR imaging; second, a nodule showed hyperintense on the ferucarbotran-enhanced accumulation-phase T2WI or FS-T1WI/T2*-EPI, the nodule.

Results

In characterization of the T1W hyperintense nodules, an excellent agreement of inter-observer agreement between the two reviewers was noted in the ferucarbotran-enhanced group (k=0.86) and the gadolinium enhanced group (k=0.81). The histological grading of the T1W hyperintense nodules in both groups is shown in Table 1. The tumor numbers, sizes, signal intensities on precontrast T2WI and enhancing patterns for both groups are shown in Table 2 and Table 3. In the ferucarbotran-enhanced group, seven nodules showed hyperintense on precontrast T2WI, four nodules showed arterial enhancement during dynamic study (Fig. 1), and 8 nodules showed hyperintense on the postcontrast T2WI/T2*EPI. The other nodules showed hypointense or isointense on T2WI and no arterial enhancement during dynamic study (Fig. 2). With the conventional criteria, in the gadolinium-enhanced group, the sensitivity, specificity and accuracy were 60%, 100% and 73%, respectively. Using ferucarbotran-enhanced MR with accumulation phase FS-T1WI, the sensitivity, specificity and accuracy were 100%, 83% and 94%, respectively. The sensitivity of ferucarbotran-enhanced MR with accumulation phase FS-T1WI was better than that of gadolinium-enhanced MR imaging (p<0.05).

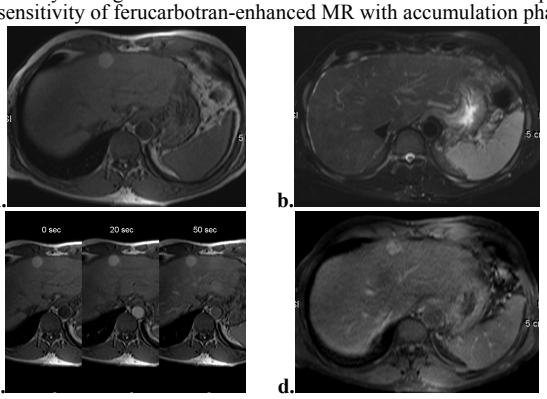

Fig. 1. A 49-y/o man with well-differentiated HCC at S3 of the liver underwent ferucarbotran-enhanced MR study. a) T1W opposed-phase image showed a hyperintense nodule on S3 of the liver. b) The nodule is slightly hyperintense on fat suppression T2WI. c) Arterial enhancement of the S3 nodule during dynamic T1W imaging was noted. d) The nodule depicted hyperintense on the accumulation-phase FS-T1WI.

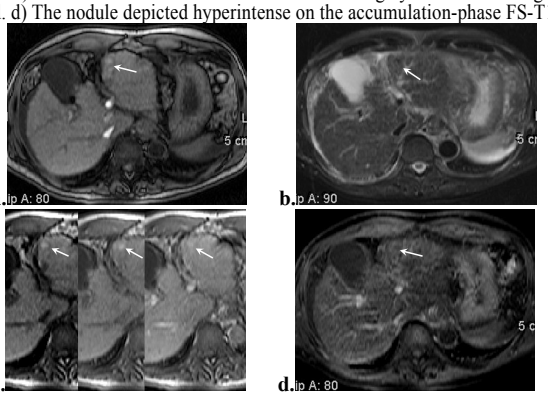

Fig. 2. A 54-y/o man with dysplastic nodules (arrow) at S3 of the liver underwent ferucarbotran-enhanced MR study. a) T1W opposed-phase image revealed a hyperintense nodule on S3 of the liver. b) The nodule was isointense on fat suppression T2WI. c) No arterial enhancement of the tumor during dynamic T1W imaging was noted. d) The nodule depicted hypointense on the accumulation-phase.

Table 1. Histological results of T1-weighted hyperintense nodules in both ferucarbotran-enhanced and gadolinium-enhanced groups.

Lesion type	Pathology	Ferucarbotran group	Gadolinium group	Total
HCC	wHCC	8	12	20
	mHCC	3	3	6
Benign nodule	DN or RN	*6	7	13

HCC, hepatocellular carcinoma; wHCC, well-differentiated HCC; mHCC, moderately-differentiated HCC; DN, dysplastic nodule; RN, regenerative nodule.
*One of the nodules was enlarged with arterial enhancement in follow-up CT and MR imaging.

Table 2. Number and size, signal intensity on T2-weighted imaging and enhancing pattern for T1-weighted hyperintense nodules in ferucarbotran-enhanced group. Values are depicted as mean±SD.

Lesion type	Tumor number	Size (cm)	Hyper on T2WI/T2*EPI		Arterial enhancement during dynamic study	"Washout" on EP FS-T1WI	Hyper on AP FS-T1WI
			Pre-contrast	Post-contrast			
HCC	11	2.3±1.3	7	8	4	1	11
Benign nodule	6	1.6±0.4	0	0	0	0	1

T2WI, T2-weighted imaging; T2*EPI, T2*-echo planar imaging; FS-T1WI, T1-weighted imaging with fat-suppression; EP, equilibrium phase; AP, accumulation phase; HCC, hepatocellular carcinoma; Hyper, hyperintense

Table 3. Number and size, signal intensity on T2-weighted imaging and enhancing pattern for T1-weighted hyperintense nodules in gadolinium-enhanced group. Values are depicted as mean±SD.

Lesion type	Tumor number	Size (cm)	T2WI		Arterial enhancement during dynamic study	"Washout" on equilibrium phase T1WI
			Hyper	Hypo or iso		
HCC	15	2.1±0.8	5	10	8	3
Benign nodule	7	1.8±0.4	0	7	0	0

T2WI, T2-weighted imaging; T1WI, T1-weighted imaging; HCC, hepatocellular carcinoma; Hyper, hyperintense; Hypo, hypointense; Iso, isointense.

Conclusion

Ferucarbotran-enhanced MR imaging with accumulation-phase FS-T1WI is superior to gadolinium-enhanced MR imaging in characterization of T1W hyperintense nodule within cirrhotic liver. T1W hyperintense nodule within cirrhotic liver depicting hyperintense on ferucarbotran-enhanced accumulation-phase FS-T1WI should be investigated aggressively.