Ferucarbotran-Enhanced Magnetic Resonance Imaging in Patients with hepatic Metastases:

Prospective Quantitative and Qualitative comparison of 3.0 T and 1.5T.

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Introduction

Recently, some investigators have been using higher magnetic field strengths in research and clinical settings. With the development of actively shielded 3.0 T magnets, high-field-strength MRI has become improvement of lesion detection can be expected due to the increased signal-to-noise ratio (SNR). Superparamagnetic iron oxide (SPIO) particles such as ferucarbotran (Resovist ; Bayer Schering Pharma, Osaka, Japan) have been improved the ability to detect focal hepatic lesions, especially in hepatic metastases. SPIO particles are taken up by Kupffer cells in the liver and result in signal decrease of the normal liver parenchyma on T2- and T2*-weighted images because of a susceptibility effect, leading to an increased sensitivity for the detection of focal liver lesions as a result of a contrast improvement. However, there are few previous reports for the diagnostic performance of SPIO-enhanced MR imaging using 3.0T for detection of hepatic metastases compared with 1.5T, therefore it is still controversial for the efficacy of SPIO-enhanced MR imaging using 3.0T.

Purpose

The purpose of this study was to prospectively compare quantitative and qualitative efficacy of ferucarbotran-enhanced MR imaging using 3.0 T to 1.5T for the detection of hepatic metastases

Materials and Methods

A total of 25 patients (17 men, eight women; age range, 35-81 years) with 70 hepatic metastases underwent ferucarbotran-enhanced MR imaging using both 3.0T and 1.5T scanner. The diagnoses of hepatic metastasis were established at surgical resection (n = 20), intraoperative ultrasonography (US) while resection of primary cancers (n = 3), and the basis of tumor growth observed at follow-up examinations (n = 2). All MR studies were performed with a superconducting magnet system at two field strengths of 3.0T (Magnetom Trio, Siemens Medical Systems, Erlangen, Germany) and 1.5T (Signa Horizon LX, GE Medical Systems, Milwaukee, MI, USA) using an 8-channel body phased-array coil either. In this prospective study, pre-contrast MR imaging was obtained using 3.0T scanner. First, ferucarbotran-enhanced MR imaging (8μmol/Fe/Kg) was obtained using 3.0T scanner, and then, post-contrast MR imaging was immediately obtained using 1.5T scanner on the same day. At MR imaging, a breath-hold T1-weighted gradient-echo (GRE) images(TR/ TE/ FA= 150-200/ 1-3/ 77-90), a breath-hold T2*-weighted GRE images(TR/ TE/ Echo train length= 3000-7468/ 71-85/ 11), and respiratory-triggered T2 – weighted fast spin-echo (FSE) images(TR/ TE/ FA= 120-171/ 8.8/ 60) were performed by both of them. Each image was obtained without parallel imaging methods.

Quantitative analysis was performed by measuring the signal-to-noise ratio (SNR) of liver and hepatic metastases, and by measuring the lesion-to-liver contrast-to-noise ratio (CNR) between hepatic metastases and liver. The calculated SNR and lesion-to-liver CNR values at 3.0T and 1.5T were compared using the matched paired t-test. Two readers independently analyzed each image in random order. Qualitative analysis was performed by sensitivity for the detection of liver metastases and image artifact and overall image quality using five-point scale. The image artifact was evaluated regarding the chemical shift, susceptibility, dielectric and motion artifact. Sensitivity for the detection of hepatic metastases at 3.0T and 1.5T was compared using McNemar test. Image artifact and overall image quality was compared using Wilcoxon signed rank test. For all tests, a p-value of less than 0.05 was considered to indicate a statistically significant difference.

Results

The mean SNRs and CNRs of each group are shown in Table1. The mean SNR of the liver and hepatic metastases and lesion-to-liver CNR were significantly higher in the 3.0T sets. The mean sensitivity of MR imaging using 3.0T was significantly higher than 1.5T (Table 2). Chemical shift artifacts were significantly more frequent on T2-weighted fast SE images using 3.0T than 1.5T. Motion artifacts were significantly less on 3.0T than 1.5T, T2*-weighted GRE images using 3.0T were equivalent using 1.5T. Overall image qualities were significantly better on T2*-weighted GRE images using 3.0T than 1.5T. There was no difference between 3.0 T and 1.5 T for other image artifacts and overall image qualities on both of T1-weighted GRE images and T2 –weighted FSE images (Table 3).

Conclusion

Using 3.0T, ferucarbotran-enhanced MRI showed higher sensitivity than the images using 1.5T for the detection of hepatic metastases. On Ferucarbotran-enhanced MRI using 3.0T, higher SNR and lesion-to-liver CNR were achieved than 1.5T, moreover, the decreasing of motion artifact and the improvement of overall image quality on T2*-weighted GRE images using 3.0T might contribute the higher sensitivity.

Table 1. The results of lesion-to-liver CNR of 3.0T and 1.5T MR imaging. Mean and SD were also expressed.

Sequence	3.0T	1.5T	p-value
GRE T1WI	-28.33 ± 14.56	-6.14 ± 5.50	<0.05
FSE T2WI	66.90 ± 37.36	15.12 ± 12.08	<0.05
GRE T2*WI	71.80 ± 30.73	14.19 ± 8.86	<0.05

Table 2. The results of image artifacts and overall image quality of 3.0T and 1.5T MR imaging. Mean and SD were also expressed.

	Sequence	3.0T	1.5T	p-value
Chemical shift artifact	GRE T1WI	3.59 ± 0.71	3.53 ± 0.67	NS
	FSE T2WI	3.31 ± 0.78	3.87 ± 0.91	<0.05
	GRE T2*WI	3.28 ± 0.68	3.40 ± 0.50	NS
Susceptibility artifact	GRE T1WI	3.84 ± 0.92	3.81 ± 0.64	NS
	FSE T2WI	3.53 ± 0.84	3.56 ± 0.67	NS
	GRE T2*WI	2.81 ± 0.69	2.84 ± 0.68	NS
Dielectric artifact	GRE T1WI	4.94 ± 0.25	4.97 ± 0.18	NS
	FSE T2WI	5.00 ± 0.00	5.00 ± 0.00	NS
	GRE T2*WI	4.97 ± 0.18	5.00 ± 0.00	NS
Motion artifact	GRE T1WI	3.47 ± 0.76	3.41 ± 0.61	NS
	FSE T2WI	3.41 ± 0.91	3.41 ± 0.61	NS
	GRE T2*WI	3.41 ± 0.76	3.00 ± 0.72	<0.05
Overall image quality	GRE T1WI	3.84 ± 0.77	3.75 ± 0.62	NS
	FSE T2WI	3.69 ± 0.74	3.66 ± 0.60	NS
	GRE T2*WI	3.44 ± 0.72	3.13 ± 0.61	<0.05

Rating scale for image artifact: 1, nondiagnostic; 2, interfering with image interpretation; 3, moderate; 4, minimal; 5, absent

Rating scale for overall image quality: 1, unacceptable; 2, poor; 3, fair; 4, good; 5, excellent

Table 3. The results of sensitivity for the detection of liver metastases of 3.0T and 1.5T MR imaging. Mean and SD were also expressed.

	3.0T	1.5T	p-value
Reader 1	93.5%	84.8%	NS
Reader 2	93.5%	80.4%	<0.05
Composite data	93.5%	82.6%	<0.05