Utility of Ferucarbotran-Enhanced T1-Weighted Spoiled Gradient Recalled Echo MR Images For Hepatic Metastases: A Prospective Comparison With 3.0 T and 1.5T.

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Background

Recently, superparamagnetic iron oxide (SPIO) MR contrast agents such as ferucarbotran (Resovist ; Bayer Schering Pharma, Osaka, Japan) has been used to improve the detection of focal hepatic lesions on T2*-weighted gradient recalled echo (GRE) and T2-weighted fast spin-echo (FSE) sequences, especially in hepatic metastases.   In addition, some investigators have suggested that the acquisition of T1-weighted GRE images may improve lesion characterization between benign and malignant lesions. They have been reported that "ring enhancement" on T1-weighted GRE images was highly suggestive of malignant lesions, and it was one of the most helpful sign for differentiating malignant lesions from benign lesion.   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), theoretically.   SPIO particles are taken up by Kupffer cells in the liver and result in signal increase on T1-weighted GRE images because of T1-shortening effect.   To our knowledge, there are no previous reports for the efficacy of SPIO-enhanced MR imaging using 3.0T.   Therefore, it is still controversial for the efficacy of the sign of "ring enhancement" with malignant lesions on SPIO-enhanced T1-weighted GRE images using 3.0T.

Purpose

The purpose of this study was to prospectively compare the frequency and qualitative efficacy of "ring enhancement" on ferucarbotran-enhanced T1-weighted GRE images 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 (IOUS) 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, ferucarbotran-enhanced MR imaging was also immediately obtained using 1.5T scanner on the same day.   On breath-hold T1-weighted GRE images (TR/TE/FA= 150-200/2.2/90°) at 3.0T and (TR/TE/FA=140-180/1.5-2.2/90°) at 1.5T 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 independent readers analyzed each image in random order. Qualitative analysis was performed by sensitivity for the detection of liver metastases and frequency of detection of "ring enhancement". Sensitivity for the detection of liver metastases and frequency of "ring enhancement" of liver metastases at 3.0T and 1.5T were compared using McNemar test.   For all tests, a p-value of less than 0.05 was considered to indicate a statistically significant difference.

Results

The lesion-to-liver CNRs on ferucarbotran-enhanced T1-weighted GRE images were significantly ($p<0.05$) higher at 3.0T (mean$\pm$SD, 28.33$\pm$14.56) than at 1.5T (6.14$\pm$5.50).   The sensitivity at 3.0T (71.7%) was slightly (p=0.063) higher than at 1.5T (66.3%) on ferucarbotran-enhanced T1-weighted GRE images.   The frequency of "ring enhancement" in hepatic metastases at 3.0T (74.2%) was significantly ($p<0.05$) higher than at 1.5T (55.7%) on ferucarbotran-enhanced T1-weighted GRE images.

Conclusion

On T1-weighted GRE images, "ring enhancement" is shown more frequent at 3.0T than 1.5T. Therefore, it is also helpful sign for characterizing hepatic metastases in ferucarbotran-enhanced MR images.