

# Which is Better for Detection of Hepatocellular Carcinoma (HCC) and Vessel Thrombus? Comparison of Superparamagnetic Iron Oxide (SPIO) - Enhanced $T_2^*$ - Weighted Imaging ( $T_2^*$ WI) and 3D Balanced Turbo Field-Echo (B-TFE) with a $T_2$ Preparation Pulse ( $T_2$ prep)

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## Introduction

Evaluation of vessel thrombosis is important for determination of the therapeutic strategy in hepatocellular carcinoma (HCC). Gadolinium ethoxybenzyl diethylenetriamine triamine pentaacetic acid (Gd-EOB-DTPA) is widely used to improve detection and characterization of liver tumors [1]. It remains difficult to detect thrombosis and to obtain the hepatobiliary phase with gradient echo (GRE) imaging because of signal loss in vessels. In addition, the possibility of developing nephrogenic systemic fibrosis (NSF) after administration of a gadolinium contrast agent exists in patients with reduced renal function. On the other hand, superparamagnetic iron oxide (SPIO) is a liver-specific contrast agent. Because SPIO is not renally excreted, it can also be used in patients with decreased renal function. It is also difficult to detect thrombosis and to obtain Kupffer phase with GRE. A balanced sequence has both  $T_1$  and  $T_2$  contrast weighting, which produces strong contrast between tissues with different ratios of  $T_1$  and  $T_2$ , and can be a very useful sequence for assessing the portal vein for thrombosis [2]. Moreover, the balanced turbo field-echo (B-TFE) technique is suited for cardiovascular imaging [3]. B-TFE with a  $T_2$  preparation pulse ( $T_2$  prep) is widely used in cardiovascular imaging.  $T_2$  prep suppresses venous blood based on  $T_2$  differences between arterial and venous blood [4]. The purpose of the present study was to compare SPIO-enhanced three-dimensional (3D) B-TFE with  $T_2$  prep and two-dimensional (2D)  $T_2^*$ -weighted imaging ( $T_2^*$ WI) in order to detect HCC and vessel thrombus in greater detail.

## Methods

MRI was performed at 1.5 T (Gyrosan Intera; Philips Medical Systems International, Best, The Netherlands), and patients were placed in a supine position with a 32-element phased-array coil (SENSE Torso Cardiac Coil). Twenty-three patients with a portal thrombus or venous thrombus were administered SPIO (Ferucarbotran, (Resovist), FUJIFILM RI Pharma, Tokyo, Japan) at a dose of 8  $\mu$ mol of iron per kilogram of body weight. After administration of SPIO, respiratory-triggered B-TFE with  $T_2$  prep and breath-hold  $T_2^*$ WI was acquired. B-TFE was acquired as follows: TR, 4.3 ms; TE, 2.2 ms; AT, 220 s; matrix size, 512  $\times$  256; FOV, 350 mm  $\times$  280 mm; NSA, 1; flip angle, 70°; slice thickness, 2 mm; number of slices, 80; bandwidth, 271.3 Hz; reduction factor, 2.0; fat suppression, and a spectral pre-saturation inversion recovery (SPIR)  $T_2$  prep pulse of 4.  $T_2^*$ WI was performed as follows: TR, 256 ms; TE, 13.2 ms; AT, 39 s; matrix size, 512  $\times$  256; FOV, 350 mm  $\times$  280 mm; NSA, 1; flip angle, 30°; slice thickness, 5 mm; number of slices, 30; slice gap, 0.5 mm; bandwidth, 271.3 Hz; and a reduction factor of 2.0. The regions of interest (ROI) in the B-TFE and  $T_2^*$ WI were delineated tumor, liver, thrombosis, and vessels. The contrast between HCC, liver, vessel, and thrombus was calculated. Two-sided tests were used for comparisons, and  $p < 0.05$  was considered to indicate statistical significance.

## Results

B-TFE with  $T_2$  prep has a high signal-to-noise ratio and flow-independent high signal from vessels (Fig. 1.).

The contrast between HCC and liver in  $T_2^*$ WI was significantly higher than in B-TFE ( $p < 0.05$ ). B-TFE exhibited higher contrast between thrombus and vessels than  $T_2^*$ WI ( $p < 0.01$ ).

## Conclusions

$T_2$  shortening occurs in the liver with SPIO. Moreover, contrast between HCC and liver was improved by  $T_2$  prep. SPIO-enhanced 3D B-TFE with  $T_2$  prep offers high spatial resolution and visualization of fine anatomical structures. It is possible to use Kupffer imaging for assessment of liver function and acquisition of morphological images using B-TFE. It may also be helpful for simultaneous detection of HCC and vessel thrombus.

## References

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Figure 1. SPIO-enhanced  $T_2^*$ WI (A,C) compared to 3D B-TFE with  $T_2$  prep (B,D) in a patient with a tumor in the right lobe of the liver (white arrows) and thrombosis (yellow arrows).

