

# Diffusion-weighted MR imaging (DWI) using TRacking Only Navigator echo (TRON): initial clinical evaluation and comparison to respiratory triggered and free breathing DWI

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## Introduction

Diffusion-weighted MR imaging (DWI) is an emerging technique for the detection and characterization of liver lesions [1]. Two types of non-breathhold DWI are used in clinical practice: respiratory triggering (RT) and free breathing (FB). However, RT DWI suffers from a prolonged examination time, while FB DWI may suffer from image blurring [1]. Recently, the limitations of both RT and FB DWI have been overcome by the introduction of TRacking Only Navigator echo (TRON) [2, 3]. TRON uses a navigator echo for continuous real-time slice tracking and does not use any gating window; consequently, scan time is not prolonged and image blurring is reduced [2, 3]. So far, TRON has only been evaluated in healthy volunteers, and not in a clinical setting. It is still unknown how TRON compares to RT and FB DWI with regard to conspicuity and apparent diffusion coefficient (ADC) measurements of liver lesions. The purpose of this study was therefore to assess conspicuity and ADCs of liver metastases in TRON, compared to RT and FB DWI.

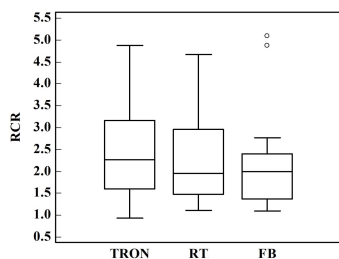
## Subjects and Methods

Fourteen patients with liver metastasis (5 men and 9 women; mean age, 58.1 years [age range, 30–77 years], 9 colorectal carcinomas, 1 mammary carcinoma, 1 adenocarcinoma of unknown primary, 1 Ewing sarcoma, 1 medullary thyroid carcinoma) underwent MR imaging of the liver at a 1.5 T-system. In each patient, DWI with single-shot echo-planar imaging was performed 1) using TRON, 2) with RT, and 3) under free breathing, at b-values of 0 and 500 s/mm<sup>2</sup>. Nominal scan times of TRON, RT, and FB were 117 s, 115 s, and 99 s, respectively. Actual scan time of RT DWI was two to three times longer. Relative contrast ratio (RCR) between the largest hepatic metastasis and the surrounding liver parenchyma ( $SI_{\text{metastasis}} / SI_{\text{liverparenchyma}}$ ), and ADC of the hepatic metastasis were measured, in each patient, for each DWI sequence. Differences in RCRs among TRON, RT, and FB DWI were assessed using one-way repeated measures analysis of variance (ANOVA), with the level of statistical significant difference set at  $P < 0.05$ . Reproducibility of ADC measurements of liver metastases among the different DWI sequences was determined as mean absolute difference (bias) and 95% confidence interval of the mean difference (limits of agreement) according to the methods of Bland and Altman.

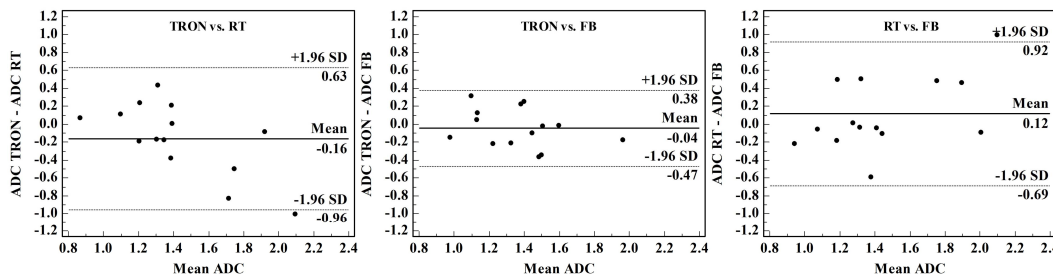
## Results

Mean RCRs  $\pm$  SDs between the hepatic metastasis and the surrounding liver parenchyma were  $2.38 \pm 1.03$  for TRON,  $2.37 \pm 1.18$  for RT, and  $2.28 \pm 1.24$  for FB, without any significant differences among them ( $P = 0.971$ ) (Figure 1). Mean difference in ADC measurement  $\pm$  limits of agreement (in  $10^{-3}$  mm<sup>2</sup>/s) between TRON and RT, between TRON and FB, and between RT and FB were  $-0.16 \pm 0.79$ ,  $-0.04 \pm 0.43$ , and  $0.12 \pm 0.81$ , respectively (Figure 2). Figure 3 shows a representative example of a liver metastasis depicted by DWI using TRON, compared to RT and FB DWI.

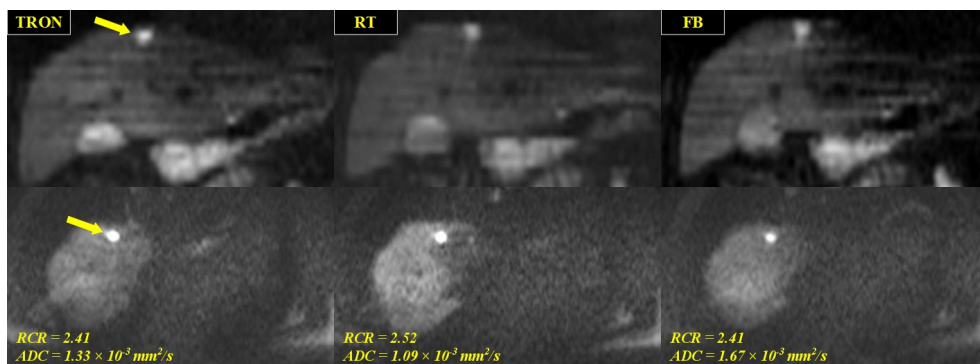
**Figure 1.** Box-and-whisker plots of RCRs between the hepatic metastasis and the surrounding liver parenchyma in FB, RT, and TRON.



**Figure 2.** Bland–Altman plots of difference of ADC measurements (y-axis) against mean ADC measurement (x-axis), with mean absolute difference (bias) (continuous line) and 95% confidence interval of the mean difference (limits of agreement) (dashed lines) for TRON vs. RT (left), TRON vs. FB (middle), and RT vs. FB (right).



**Figure 3.** Representative example of DWI of the liver using TRON, compared to RT and FB DWI, in a 77-year-old male with a liver metastasis from colon carcinoma (arrow). **Upper row:** coronal reformatted images; **lower row:** axial images. RCRs between the hepatic metastasis and the surrounding liver parenchyma in TRON, RT, and FB were similar. Actual scan time of RT DWI, however, was approximately two to three times longer than in TRON and FB DWI. Furthermore, note less blurring of the lesion in TRON DWI than in FB DWI. Remarkably, ADCs of the hepatic metastasis in TRON, RT, and FB were considerably different.



## Conclusions

The results of this study indicate that conspicuity of liver metastases between TRON and RT DWI is equal, using a two-to-threefold shorter actual scan time for TRON DWI. Conspicuity of liver metastases between TRON and FB DWI was also equal, but image blurring is less in TRON DWI [2]. TRON may therefore be an excellent alternative to RT and FB DWI. Reproducibility of ADC measurements of liver metastases between TRON and RT DWI, and between RT and FB DWI was poor, while reproducibility of ADC measurements of liver metastases between TRON and FB DWI was moderate; this potential impediment for reliable diffusion quantification of liver metastases requires further investigation.

## References

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2. Takahara T, et al. Respiratory gated body diffusion weighted imaging avoiding prolongation of scan time: tracking only navigator echo (TRON) technique. Presented at the Joint Annual Meeting ISMRM-ESMRMB, Berlin, Germany, May 19–25, 2007.
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