Respiratory Gated Body Diffusion Weighted Imaging (DWI) Avoiding Prolongation of Scan Time: Tracking Only Navigator Echo (TRON) Technique: Improvement for high b value DWI.

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Background and Purpose:

The recently developed diffusion-weighted whole-body imaging with background body signal suppression (DWIBS) sequence allows diffusion-weighted imaging (DWI) during respiratory motion (1). DWIBS is feasible because respiratory motion is coherent motion, and does not cause signal decrease (2). However, blurring of objects close to the diaphragm can occur in DWIBS. Respiratory triggering using a navigator echo reduces blurring, but gating prolongs scanning time. Therefore, we previously developed the TRacking Only Navigator (TRON) technique, which accepts all data and employs only active slice tracking. TRON resulted in only 4% additional scanning time with good image quality at low b value (50 s/mm^2) (3).

Two software developments for TRON at high b value have recently been introduced. First, the required time to estimate the position of the diaphragm has been reduced. Second, time lag between slice excitation and subsequent navigator has been reduced. In this study, we investigated image quality and scanning time using the new TRON version at high b value.

Methods:

Ten volunteers were examined at 1.5 T. Imaging parameters for DWI were: TR of 4897 ms, TE of 65 ms, number of excitations of 5, acquisition matrix of 112, number of slices of 42, b value of 1000 s/mm^2, theoretical scan time of 2m18s. Time lag between a navigator and first slice excitation was 5 ms (compared to 35 ms previously) (Fig.1, TD1). Time lag between the last slice excitation and following navigator was 0 ms (compared to 400 ms previously) (Fig.1, TD2), which was accomplished by ignoring the saturation band on the navigator profile by the previous slice excitation (Fig.2). Image quality of conventional TRON and improved TRON was compared at b value of 1000 s/mm^2. Additionally, image quality and scanning time of coronally reformatted DWI with TRON, conventional respiratory triggering (RT), and free breathing (FB) was compared.

Results:

The interval of each navigation was reduced by 430 ms. Improved TRON sequence did not show significant step-ladder artefact at b value of 1000 sec/mm2 (Fig.3). Actual scanning time was 2m21s (TRON), 6m24s (RT), and 2m18s (FB). Relative scanning time to FB was 104% with TRON and 272% with RT. Image quality of new TRON was comparable to RT (not shown).

Discussion and Conclusion:

High b value DWI uses a long TE, which results in long duty cycle, long scanning time, and poor tracking quality due to increased time lag between navigator and slice excitation. The use of TRON concept and reduction of time lag in navigator sequence allows us practical high b value DWI in a short scan time.

Figure 1: Schema of TRON sequences.

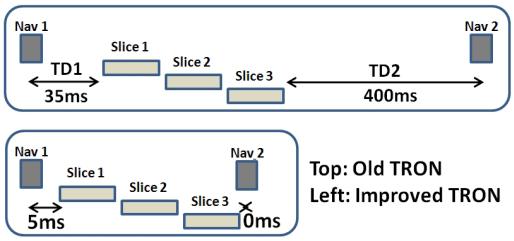


Figure 2: Navigation profile improvement (left: old, right: improved)

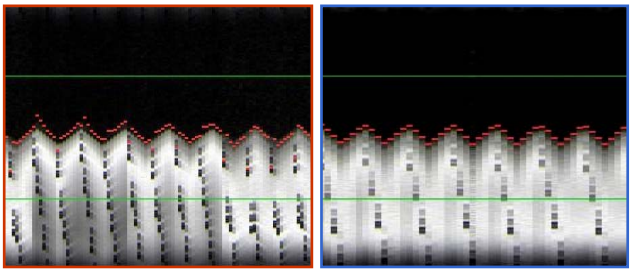
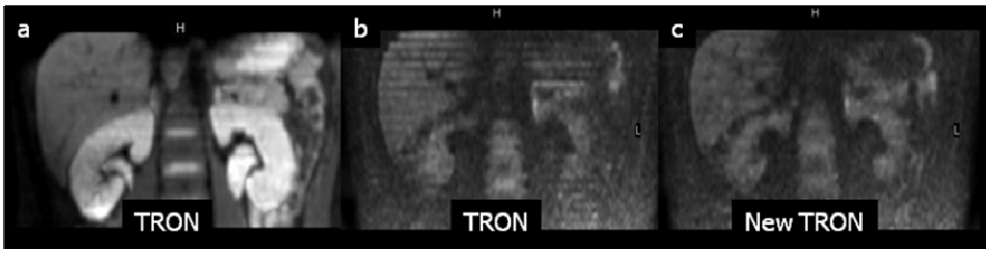


Figure 3: Comparison of conventional and improved TRON at b=50 and 1000 sec/mm^2.



(a) DWI with old TRON at b=50 shows good tracking. (b) DWI with old TRON at b=1000 shows multiple step-ladder artifact suggesting poor tracking accuracy. (c) DWI with improved TRON shows fewer artifacts.

References: 1) Takahara T, Imai Y, et al. Radiat Med 2004; 22:275-282. 2) Koh DM, Takahara T, et al. MRMS Dec, 2007 (in press). 3) Takahara T, Ogino T, et al. ISMRM proceedings, 2006.