

Single breath-hold T1 measurements using segmented inversion recovery prepared TrueFISP sequence at 3 T

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Introduction

Measurements of the longitudinal relaxation time T1 are required for many applications such as tissue and pathology characterization, sequence optimization, and estimates of the contrast agent concentrations in dynamic contrast-enhanced MR experiments. Most conventional methods of T1 measurements require several breath-holds, which may result in image misregistration. Single breath-hold acquisition method of a T1-map of the abdomen using segmented inversion recovery prepared TrueFISP sequence (sIR-TrueFISP) has been implemented at 3 T. Higher field is expected to improve the signal-to-noise ratio of the low flip angle acquisitions.

Methods

Imaging was performed on 3 T scanner (Magnetom TIM Trio, Siemens). Segmented IR-TrueFISP sequence with $\alpha/2$ pre-pulse and a readout consisting of a series of α -pulses [1-3] was used with the following parameters: TR/TE/flip angle=4000/3.4/10°. A series of images, with each image acquired at an inversion time $t_i=t_0+i\times\Delta t$, where $t_0=25$ ms, $\Delta t=100.4$ ms, $i=0, 1, 2, \dots, 37$, was captured within a single 20 s breath-hold. Resulting signal intensity images were fitted pixel by pixel with a low-flip angle IR-TrueFISP formula:

$$M(t) = \frac{M_0(1 - 2\exp(-t/T1) + \exp(-TR/T1))}{1 + \exp(-TR/T1)}, \text{ with } M_0 \text{ and } T1 \text{ as free parameters.}$$

Results

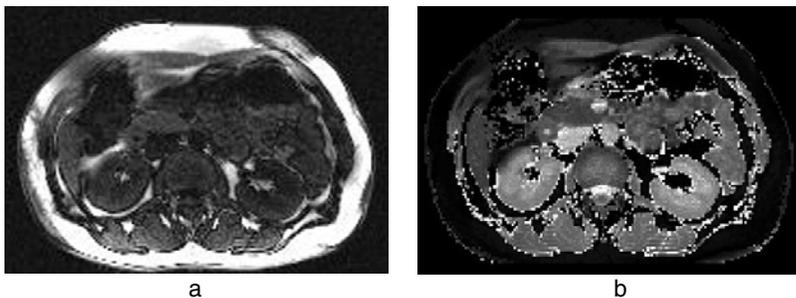


Figure 1. Abdominal 10° IR-TrueFISP image at $t_i=1435$ ms (a) and T1 map (b) for the same slice

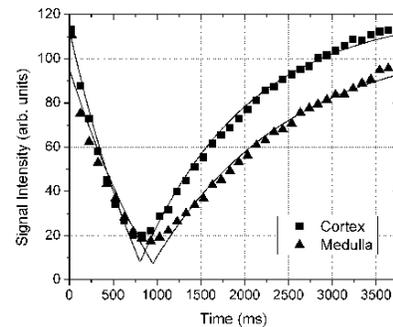


Figure 2. Signal intensity for renal cortex and medulla (symbols) and respective curve fits (solid lines)

Figure 1 shows a representative abdominal image obtained using low flip angle sIR-TrueFISP at inversion time of 1435 ms (Fig. 1a) and a T1 map generated for this slice from a series of 38 images (Fig. 1b) from pixel by pixel fitting as described above. Figure 2 shows typical signal intensity curves obtained from ROIs placed in the renal cortex and medulla along with respective curve fits by the low flip angle IR-TrueFISP formula shown above. Typical tissue T1 values determined from the mapping are as follows: renal cortex 1233 ms, renal medulla 1530 ms, muscle 1034 ms. These T1 values for abdominal tissues are in agreement with the results of the conventional inversion recovery fast spin echo method: renal cortex 1150 ms, renal medulla 1630 ms, muscle 950 ms and close to the published results at 3 T [4].

Conclusions

Imaging with a low flip angle sIR-TrueFISP enables creating T1 maps of abdominal slices within a single breath-hold. Higher signal-to-noise ratio at 3 T considerably improves the quality of the images, which can be problematic at lower field. The stronger effect of field inhomogeneities, to which sIR-TrueFISP is very susceptible, and larger T2-effects will be investigated.

References

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