

A Simulation Framework to Investigate T1 Contamination on Diffusion Prepared RUFIS

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1 Introduction

Rotating Ultra-fast Imaging Sequence (RUFIS) is a radial acquisition scheme that allows fast and robust acquisition for magnetization prepared sequences[4]. However, T1-recovery during readout is a common issue for magnetization prepared sequences and introduces unwanted bias. Previous studies reported imaging parameters optimization [3], RF phase cycling [1] or k-space filtering [1,2] to reduce T1-contamination. In this study, we established a simulation framework to investigate the effect of imaging parameters and RF-cycling scheme on reducing T1-contamination for diffusion prepared RUFIS.

2 Methods

We set up a 3D uniform sphere phantom for simulation, represented by a 163 matrix. The phantom was assigned T2=80ms, diffusion coefficient D=10-3mm²/s and variable T1 values. We assume a perfect diffusion preparation (duration T_{prep} =50ms). 256 spokes, 8 data points and TR=1.5ms for each spoke is assigned for the readout, and encoding matrix is calculated accordingly. The simulated k-space data is multiplied by a weighting function corresponding to the evolution of longitudinal magnetization affected by T1-recovery and repetitive excitation. Algebraic image reconstruction was applied via explicit inversion of the encoding matrix. The diffusion coefficient is calculated based on the model $\log(S/S_0) = -bD$. A region in the central part of the image profile was chosen, and the mean calculated diffusion coefficient D_{cal} was compared to the input D_{in} . The systematic deviation of measurement is represented in percentage: $DEV = (D_{cal} - D_{in})/D_{in} * 100\%$. The impact of flip angle and b-value on the underestimation of D , as well as the correction method using phase cycling [1] was investigated.

3 Results

As shown in Fig.1(A), the underestimation of D caused by T1-recovery during readout can be up to 40% for b=1000s/mm², and is more predominant with

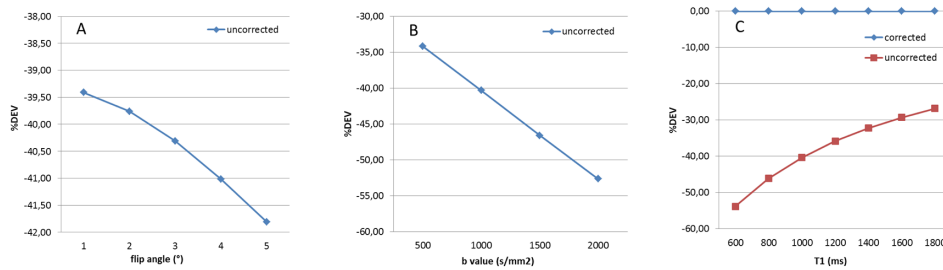


Fig. 1. Underestimation of diffusion coefficient with different imaging parameters: (A) flip angle, (B) b value. (C): comparison of D underestimation with and without correction. T1 value was set to 1000ms for (A) and (B), flip angle was set to 3° for (B) and (C).

increasing b-value, flip angle and decreasing T1. The RF-cycling scheme reduces the bias to be less than 1%.

4 Discussion

Our results confirmed significant underestimation of D caused by T1-recovery in diffusion prepared RUFIS. Unlike turboFLASH in which the problem can be ameliorated by centric phase encoding, in RUFIS the T1-contamination affects the whole k-space. Our results suggest that more accurate measurement can be conducted with lower b value and flip angle, however at the cost of reduced SNR. The RF-cycling scheme eliminates the T1 contamination. The study can be extended for investigating other imaging parameters as well as techniques to reduce T1-contamination.

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