The effect of magnetization transfer on rapid T2 estimation with phase-cycled variable nutation SSFP

H. J. Crooijmans[1], K. Scheffler[1], and O. Bieri[1]

[1]Radiological Physics, University of Basel Hospital, Basel, BS, Switzerland

Introduction

Phase-cycled variable nutation steady-state free precession (SSFP) is capable of generating T2 maps within clinical acceptable acquisition times [1]. However, when imaging the human brain or tissues, one should be aware of magnetization transfer (MT) effects inherent to SSFP [2,3], which might influence the outcome of such analysis (as already observed with T1 [4]). Short repetition times (TR) and short RF pulses are used to minimize acquisition time. When doing so, MT effects influence the found T2 values. In this abstract the influence of MT on quantitative T2 brain mapping by means of the DESPOT2 method is given for a range of RF pulse durations for hard pulses.

Materials and Methods

Experiments are performed on an Avanto 1.5T whole body scanner (Siemens, Erlangen, Germany). T1 maps are calculated according to the DESPOT1 method [5,6] based in two RF spoiled gradient echo (SPGR) acquisitions with different flip angles α. T2 is calculated by the DESPOT2 method [6] based on the T1 map and two balanced SSFP (bSSFP) measurements at different flip angles. Since MT effects depend strongly on RF pulse power and thus on RF pulse duration [3], MT effects on DESPOT2 are explored using several non-slice selective RF pulse durations ranging from 150µs to 2100µs with corresponding repetition times TR = 2580 to 4530ms (see Fig. 1). For reference T2, a multi contrast spin echo (mcSE) acquisition is performed with 20 echoes (echo spacing of 10ms). All Data was acquired in 3D (256x256x128 matrix size) yielding 1.33x1.33x1.33mm resolution, except for mcSE, where a 2D multi-slice scan was used having essentially the same in-plane resolution but 2mm slice thickness. All data is registered to MPRAGE (serving as anatomical reference). Sequences and protocols used are summarized in Table 1.

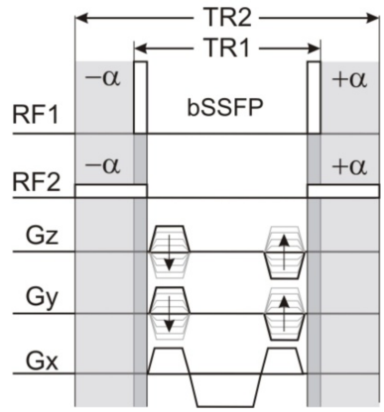

Figure 1: 3D bSSFP sequence scheme with non-slice selective excitation. TR1: minimal TR using short RF pulse durations; TR2: maximal TR using long RF pulse durations. Prominent MT effects are expected to be present in the scheme using TR1, whereas signal modulation from MT is expected to be reduced in the scheme using TR2 as a result of

Table 1: Sequence parameter settings

sequence	*MPRAGE*	*SPGR*	*bSSFP*	*mcSE T2*
Use	*Anat. reference*	*DESPOT1*	*DESPOT2*	*reference*
TR [ms]	1760.0	9.8	2.580-4.530[1]	4470.0
α [deg]		3/17	15/55	90
BW [Hz/px]	130.0	140.0	790	245.0

[1] TR = 2.580ms for minimal RF = 150us, TR = 4.530ms for maximal RF = 2100us.

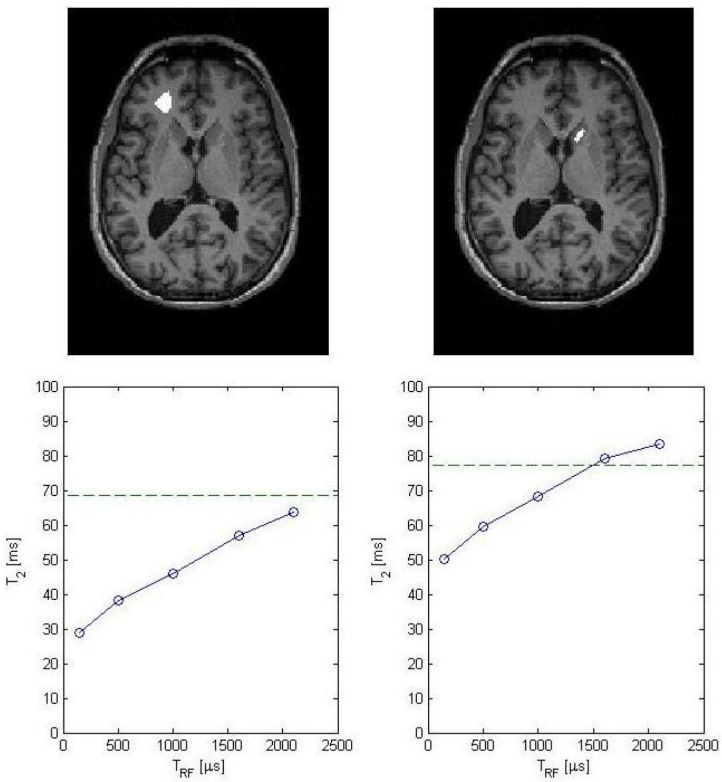

Figure 2: Two MPRAGE images (top row) with selected white (left, frontal white matter) and gray (right, caudate nucleus) matter ROIs indicated in clear white with corresponding T2 values as observed with DEPSOT2 (circles) as a function of RF pulse duration. The green dashed line shows the reference T2 value acquired by mcSE.

Results

T2 values derived with DESPOT2 are displayed in Figure 2 as a function of RF pulse power and thus of RF pulse duration exemplarily for two regions of interest: one in a gray matter structure and one in white matter. For reference, the T2 value found with mcSE is indicated as well. It is evident, that both for gray and for white matter the deviation from the true T2 increases with shortening of the RF pulse duration and thus with increasing MT related signal modulations. DESPOT2 MT modulation can be quite severe and up to two-fold for short as compared to long RF pulses.

Discussion and Conclusion

As described recently, MT effects for tissues become prominent for SSFP with large flip angles (55°) and short RF pulses [2,3]. As expected, proper assessments of T2 with DESPOT2 fails with short RF pulses as a result of MT-related signal modulations. It should be taken into account that the RF pulse duration is of great importance when using the DESPOT2 method for quantitative imaging. Generally, RF pulses should be long enough (>2ms) in order to avoid MT effects.

References

[1] Deoni et al. MRM 52:435-439 (2004); [2] Bieri et al. MRM 56:1067-1074 (2006); [3] Bieri et al. MRM 58:511-518 (2007); [4] Xiawei Ou et al. MRM 59:835-845 (2008); [5] Homer et al. J Magn Reson 63:287–297 (1985); [6] Deoni et al. MRM 45:515-526 (2003)