B1 insensitive saturation recovery T1 measurements at 3 Tesla using Water Suppression Enhanced through T1 effect (WET) saturation pulse

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Introduction

Quantitative measurements of MR properties like transverse (T2) and longitudinal (T1) relaxation rates are relevant parameters for diagnosis and prognosis of various diseases. T1 measurement is particularly important in the development of T1-based contrast enhanced perfusion measurement analysis [1]. However, relaxation time measurements depend truly on B1 homogeneity since RF-pulse angles are computed in signal analysis. This problem is even more severe at high field scanners and recent work has been reported to compensate for B1 inhomogeneity induced errors by B1 mapping [2]. We demonstrate here the use of optimized four-pulse **W**ater suppression **E**nhanced through **T**1 effects (WET) [3] for B1 insensitive saturation recovery T1 measurements at 3T, without the use of B1 mapping.

Methods

All MR experiments were performed on a 3.0 Tesla clinical scanner (Achieva – Philips Medical Systems, the Netherlands) using non-standard software. For saturation recovery measurements: A Spoiled Gradient Echo with TR/TE/FA = 3.9ms/1.85ms/30°; FOV = 230mm, BW = 459Hz, acq./recon. voxels: 2.40×2.99 / 0.90×0.90mm, 4 slices of 8mm (5mm gap), low-high k-space order, SENSE factor = 2; 8 ch. SENSE head coil. Saturation prepulse was either a 90° hard pulse, or consisted of the four-pulse WET saturation pulse (FA = 88.9, 98.7, 82.5, 158.7°, phase = 0, 90, -180, -90 respectively, with 10 ms interval between pulses and crusher gradients [4]. Ten different saturation delays [50 – 10000ms] were used. A standard Look-locker sequence was also used with the following parameters: TR/TE/FA = 3.1/1.03ms/6°, SENSE factor = 1.5, minimum inversion time = 6.6ms and 111.1ms acquisition interval. Phantoms with 4 different Gadolinium chelate (Magnevist – Schering) concentrations in Agarose gel (Sigma – Aldrich) were prepared (0.05 - 2.0 mM). 2 ROIs of same dimension were defined in the centre and at the periphery of each slice and corresponding R1/T1 values were calculated. In-vivo measurements were performed on one healthy volunteer after phantoms measurements.

Results and Discussion

The B1 insensitivity of the WET saturation pulse is shown in Figure 1, where T1 is constant over the whole slice. On the other hand Hard saturation pulse shows a T1 variation between the centre and outer ROI within slices. For comparison, an inversion recovery look-locker measurement was performed. T1 variation is also observed due to B1 sensitivity of Look-locker inversion pulse.

T1 relaxation rates for white and gray matter are in excellent agreement with the literature [4]. The WET saturation recovery sequence allows good segmentation of white and gray matter in the brain without the use of B1 inhomogeneity correction as shown in figure 2.

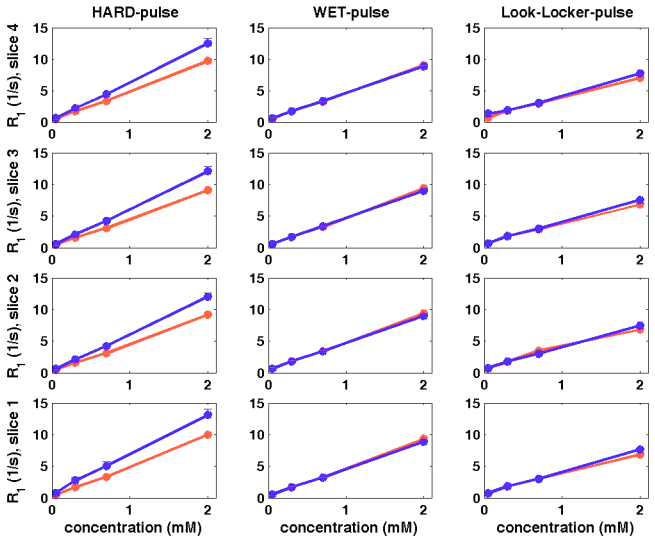

Figure 1: R1 values calculated from centre (red) and outer (blue) ROIs for all slices

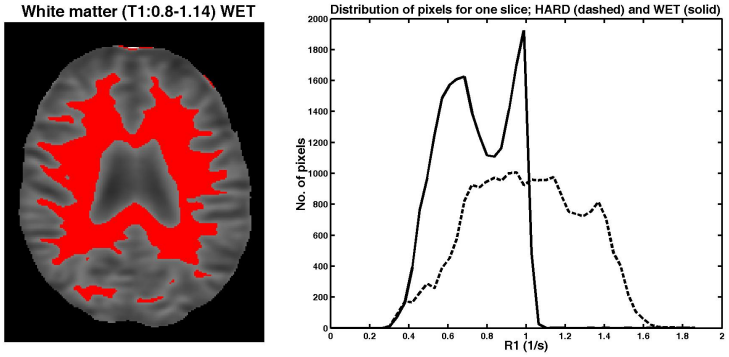

Figure 2: Segmented white matter from WET saturation recovery T1 map (left) and R1 histogram of Hard (dashed) and WET (solid) saturation pulses for the entire slice (right).

Conclusion

The B1 insensitivity of the four-pulse WET saturation pulse has been demonstrated, and T1 relaxation values of white and gray matter are obtained without the need of prior B1 mapping. The saturation recovery is the desirable approach since brain tissues saturation is required for contrast enhanced T1 perfusion analysis.

References

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