

T2* mapping at 7 T

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Introduction: Previous studies at 7 T have related T_2^* maps to the iron deposition in brain tissue, notably in putamen and other areas where iron deposition showed strong correlation with brain age [1]. However, field inhomogeneities and susceptibility distortions at 7 T are significantly higher compared to lower field strengths. This potentially distorts T_2^* values and could lead to erroneous estimates of the tissue iron content. A method based on susceptibility gradient maps has been proposed to correct for T_2^* shortening due to susceptibility distortions [2, 3], showing promising results in clinical studies at 3 T. In this study, the same T_2^* correction method was applied to 7 T and improvements to the overall T_2^* maps were evaluated.

Methods: All data were acquired on a 7 T MR scanner (Siemens MAGNETOM, Erlangen, Germany) using a 24-channel head coil. A modified RF-spoiled 2D multiple gradient echo sequence (224x256 matrix, 0.78x0.78 mm² in-plane resolution; TR = 51 ms; flip angle = 35°) was employed for image acquisition. Eight echo times (TE) were used (8, 13, 18, 23, 28, 33, 38, 43 ms). Three different slice thicknesses (1.5, 2.0, 2.5 mm) were used to investigate the through plane dephasing effect. MATLAB and SPM5 were used for data processing. Susceptibility distortion correction followed the procedures described in [2]. Regions of interests (ROIs) in several different brain regions were selected and the T_2^* values before and after correction were compared.

Results and Discussion: A representative slice of the T_2^* maps acquired with different slice thickness is shown in Fig. 1, with (top) and without (bottom) correction for susceptibility distortions applied. In the left and right temporal lobe, the T_2^* values increased significantly upon correction, by about 2 to 6 ms (Table 1). Uncorrected T_2^* values also showed a strong dependency on the slice thickness, obviously due to through-plane dephasing, which reduces T_2^* in the left temporal lobe by up to 5.5 ms when increasing the slice thickness from 1.5 mm to 2.5 mm. This effect was fully recovered by the distortion correction procedure (Table 1). In contrast, the through-plane dephasing reduces the T_2^* by up to 8 ms in the right temporal lobe, and was only partially recovered, possibly due to non-linear inhomogeneities in this region. In comparison, a selected region in the parietal white matter with small field distortion only showed minor T_2^* differences (0.5 ms) before and after the distortion correction. Our experimental results are consistent with the 3 T findings and show that the method can be applied to 7 T. Since the susceptibility gradient scales with field strength, further optimization is required to improve the performance at 7 T, e.g. by including higher order field distributions.

Conclusion: A T_2^* correction method first described for 3 T was applied to 7 T, resulting in considerably improved T_2^* maps. This method therefore should help to improve the accurate determination of T_2^* at 7 T for clinical studies. However, stronger dephasing is encountered, so thinner slices should be chosen than at lower fields to avoid systematic errors.

Acknowledgement: This work is supported by the European Union sponsored CBBS NeuroNetwork project.

References: 1. Yao B. *et al. NeuroImage* 44:1259–66 (2009) 2. Preibisch C. *et al. MRM* 60:908–16 (2008). 3. Baudrexel S. *et al. MRM* 62:263–8 (2009)

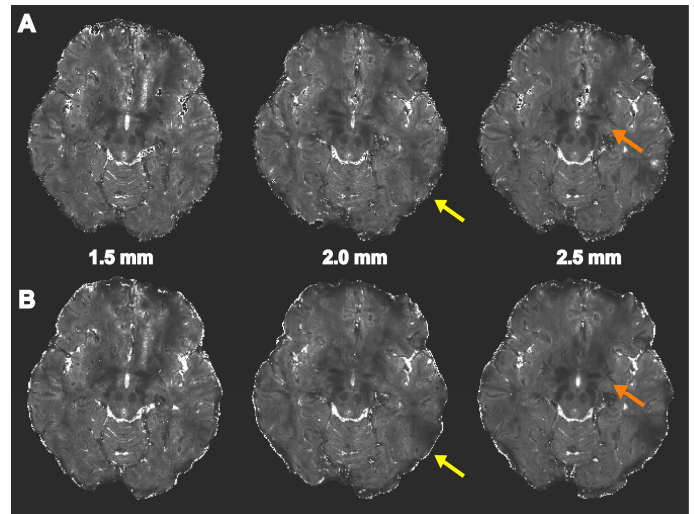


Fig 1: T_2^* maps in a selected slice after (A) and before (B) susceptibility distortion correction. Significant improvement can be observed in regions highlighted by the arrows.

Table 1: T_2^* values (in ms) in selected brain regions before (uncor) and after (cor) distortion correction for three different slices.

	1.5 mm		2.0 mm		2.5 mm	
	cor	uncor	cor	uncor	cor	uncor
Left temporal lobe (A)	28.85	26.8	28.0	24.1	28.3	21.2
Right temporal lobe (B)	25.4	19.1	20.6	12.7	16.5	11.2
Parietal WM	38.3	37.9	33.1	32.7	33.1	32.4

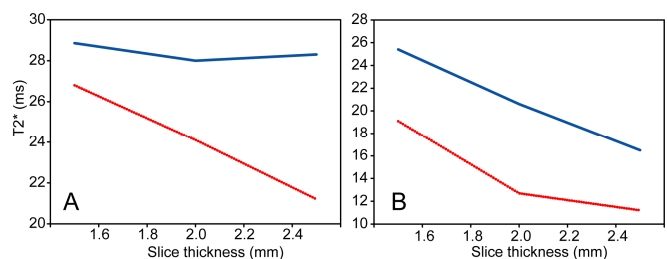


Fig 2: Comparison of T_2^* values before (red) and after (blue) correction in left (A) and right (B) temporal lobe with strong susceptibility distortion for three different slice thicknesses (1.5, 2.0 and 2.5 mm). The T_2^* values are mostly recovered in the left temporal lobe while the right temporal lobe is only partially recovered due to high order susceptibility gradients.