T2 Relaxation Times of the Limbic System: Comparison of 1.5 T and 3.0 T

E. Y. Kim[1], X. Golay[2,3], S-K. LEE[1], S. Y. Kim[1], D. J. Kim[1], J. Kim[1], S. S. Kim[4], D. I. Kim[1]

[1]Dept. of Radiology, Research Institute of Radiologic Science, Yonsei University College of Medicine, Seoul, Korea, Republic of, [2]Singapore Bioimaging Consortium, ASTAR, Singapore, Singapore, [3]Dept. of Neuroradiology, National Neuroscience Institute, Singapore, Singapore, [4]Dept. of Radiology, Kangwon National University College of Medicine, Chunchon, Korea, Republic of

Introduction

Many researches have demonstrated that 3.0 Tesla (T) MRI has numerous advantages over 1.5 T, including increase in both signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR). Therefore, 3.0 T is becoming popular and may be on the verge of becoming the clinical standard. A review of the literature suggests that the neocortex shows 14% to 30% longer T1 relaxation time and 12% to 19% shorter T2 relaxation time at 3.0 T, compared to the values at 1.5 T (1). Therefore, the neocortex demonstrates lower signal intensity on FLAIR and T2-weighted imaging at 3.0 T than at 1.5 T. The limbic system shows higher signal intensity on FLAIR imaging than that of the neocortex at 1.5 T; as for the hippocampus, it demonstrates highest signal intensity (2). Recently, we observed higher signal intensity in the cingulate gyri demonstrated on FLAIR at 3.0 T, as compared to 1.5 T. We hypothesized that T2 relaxation time of the cingulated gyri is less shortened at 3.0 T, compared to the value at 1.5 T. The purpose of this study is to compare T2 relaxation times in the hippocampus, cingulated gyrus, amygdaloid body, and insular cortex between 1.5 T and 3.0 T.

Methods

Twelve healthy volunteers (each of 6 male and female; mean age, 30.9 years) underwent MRI at both 1.5 T and 3.0 T (Intera Achieva, Philips Medical Systems). MR imaging consisted of FLAIR and Carl-Purcell-Meiboom-Gill (CPMG) sequence for T2 relaxation time measurement. Coronal imaging perpendicular to the hippocampus was obtained with the same parameters at both 1.5 T and 3.0 T. The parameters of FLAIR were determined according to the results of optimization at both 1.5 T and 3.0 T (1). The CPMG sequence was performed with 8 echo times using parallel imaging (factor of 2). Thickness and matrix were 3 mm and 512 * 512, respectively. Regions of interest (ROI) were drawn in the cingulate gyrus, hippocampus, amygdaloid body, and insular cortex on both sides on FLAIR images (Fig. 1). Thereafter, the ROIs were copied to the corresponding T2 relaxation time maps for measurement. The percentage change of T2 relaxation times was calculated between 1.5 T and 3.0 T. The T2 relaxation time ratios of the cingulate gyrus, insular cortex, and amygdaloid body to the hippocampus were compared between 1.5 T and 3.0 T. The Kruskal-Wallis test and Wilcoxon signed ranks test were used to compare percentage change of T2 relaxation times and T2 relaxation time ratios between 1.5 T and 3.0 T, respectively.

Results

The mean T2 relaxation times on each side of the cingulate gyrus, insular cortex, amygdaloid body, and hippocampus at 1.5 T were 109.5 ± 3.1, 111.3 ± 2.4, 117.0 ± 7.1, 114.7 ± 2.4, respectively; 99.7 ± 3.8, 96.2 ± 2.0, 100.7 ± 4.3, 97.9 ± 3.4, respectively, at 3.0 T. Percentage changes of T2 relaxation time in the cingulate gyrus, insular cortex, amygdaloid body, and hippocampus at 3.0 T with respect to those at 1.5 T were -8.9%, -13.5%, -13.5%, and -14.6%, respectively (Table 1). The percentage change of T2 relaxation time in the cingulated gyrus was significantly lower than in the others ($p = 0.006$). The mean T2 relaxation time ratios of the cingulate gyrus, insular cortex, and amygdaloid body to the hippocampus at 1.5 T and 3.0 T were 0.96 and 1.02 ($p = 0.003$); 0.97 and 0.98 ($p > 0.05$); 1.00 and 1.00 ($p > 0.05$), respectively.

Discussion and Conclusion

The cingulate gyrus and insular cortex show higher signal intensity on FLAIR at 1.5 T (2), which may be due to their higher water content. The higher water content in the specific parenchyma will make it less dependent on magnetic field strength. Therefore, the cingulate gyrus demonstrates less percentage change, compared to the other structures. However, we cannot answer the question of why such a reduction in relaxation time changes was not present in the insula. Further investigation for this issue would be needed. The clinical implications of this study are as follows: first, higher signal intensity in the cingulate gyrus on FLAIR may mimic the findings of viral encephalitis. Therefore, the radiologists should be aware of this finding. Second, the T2 relaxation time ratios reflect signal intensity ratios on FLAIR, which is obtained in routine practice. The result of near the same signal intensity of the cingulate gyrus and hippocampus may be applicable to diagnose hippocampal sclerosis in epilepsy patients. In conclusion, T2 relaxation time decrease in the cingulate gyrus was less than the insular cortex, amygdaloid body, and hippocampus at 3.0 T, resulting in relatively higher signal intensity compared with that of the hippocampus on FLAIR at 3.0 T.

Table 1. T2 relaxation time measurement at both 1.5 T and 3.0 T

	Cingulate Gyrus	Insular Cortex	Amygdala	Hippocampus
1.5 T	109.5 ± 3.1	111.3 ± 2.4	117.0 ± 7.1	114.7 ± 2.4
3.0 T	99.7 ± 3.8	96.2 ± 2.0	100.7 ± 4.3	97.9 ± 3.4
% change	-8.9%*	-13.5%	-13.5%	-14.6%

*$p = 0.006$

Table 2. Mean T2 relaxation time ratios to the hippocampus

	Cingulate Gyrus	Insular Cortex	Amygdala
1.5 T	0.96*	0.97	1.00
3.0 T	1.02*	0.98	1.00

*$p = 0.003$

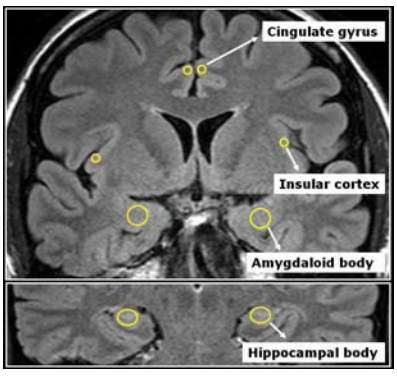

Fig. 1. Regions of interest

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