T1 and T2 mapping of the human cervical spinal cord at 3 Tesla

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Introduction: The cervical spinal cord (SC) is a frequent site of pathology in several neurological diseases. However, quantitative imaging is hampered by the small size, the anatomical location and the mobile nature of the SC. While in vivo human tissue relaxation parameters have been reported in the brain at 3 T, to our knowledge, there is only one study that has reported the value of T_1 and T_2 relaxation times in the spinal cord at 3T in vivo (1). T_1 and T_2 were measured in white matter (WM) and grey matter (GM) in the cervical SC at the level of C2 and C3 based on the assumption that the T_1 and T_2 relaxation rates would mimic those measured in the brain at the same field strength. The aim of this study was to measure the T_1 and T_2 relaxation times of the human SC using a 3-point GRE T1 mapping method with built-in B1-correction (2) and spin-echo sequence with protocol optimization based on 2-point measurements of T_2s (3) respectively.

Material and methods: 10 healthy volunteers (mean age 28.1 ± 2.2 years) underwent MRI of the cervical spine on a 3T scanner (Siemens Medical Solutions, Erlangen, Germany) with a 4-channel phased array neck coil. The study was approved by the local IRB and informed consent was obtained from all subjects. The MRI protocol included: Sagittal T2-weighted TSE, axial T2-weighted FLASH, T1 3D GRE and 2D T2 SE. The sequence parameters for the 3-point 3D GRE T1 were: TR: 32/32/53 ms, FA: 6/31/125 degrees, TE: 7.4 ms, FOV: 256x256x128 mm3 with 240x240x32 imaging matrix providing 1.07x1.07x4 mm^3 image resolution. Acquisition time: 15 min. Sequence parameters for the 2D T2 SE were: TE: 7.8/85 ms, 24 contiguous axial slices, FOV: 208x256mm^2 with 208x256 imaging matrix providing 1.0x1.0x4 mm^3 image resolution. To reduce motion artifacts, flow compensation in slice-select direction was applied. To reduce in-flow effects associated with cardiac pulsation in the longer echo T2 acquisitions, cardiac gating was employed and the minimum TR was set to 2.5 s. Acquisition time: 20 min with acceleration factor of 2. For each subject four regions of interest (ROI) were analyzed on 3 consecutive slices at two SC segments (C2 and C3): left and right lateral column WM, dorsal column WM and the anterior horn GM. Four ROIs were placed on the high resolution T2-weighted images and transferred onto the co-registered absolute T_1 and T_2 maps (**Figure 1**).

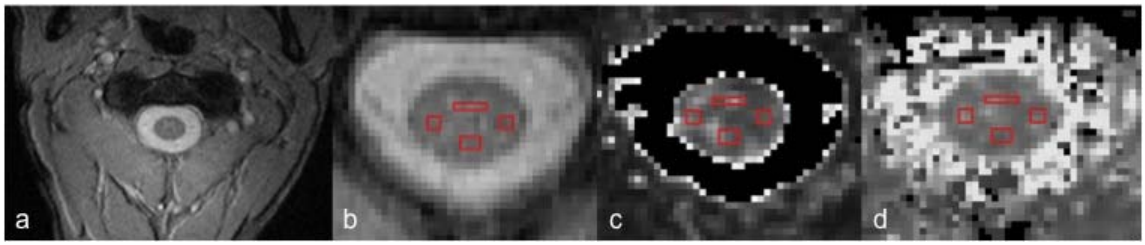

Figure 1: ROI location in one healthy subject. Axial T2-W image (a), same image magnified to show ROIs location, corresponding T2 map (c) and T1 map (d).

Results and discussion: Mean values of the T_1 and T_2 relaxation times for C2 and C3 are reported in **Table 1**. The T_1 relaxation times measured in our study were lower and the T_2 relaxation values were higher than those reported by Smith et al. (1). The latter might be explained by the fact that, when using a 16-echo SE sequence, the B_1 inhomogeneities can produce a cumulative effect on each of the 180° pulses leading to an underestimate of T_2. In addition, an undesired diffusion weighting may be introduced by use of the TSE sequence leading to a decrease in T_2 values in comparison to those measured with a SE sequence.

	C2			C3		
	Lateral column	**Dorsal column**	**Gray Matter**	**Lateral column**	**Dorsal column**	**Gray Matter**
T_1 (ms)	810 ± 24	905 ± 31	805 ± 28	794 ± 33	800 ± 33	835± 25
T_2 (ms)	95 ± 3	92 ± 2	94 ± 3	93 ± 5	93 ± 3	95 ± 3

Table 1: Mean ±SD for absolute T1 and T2 values at C2 and C3 levels.

Conclusion: This study demonstrates the feasibility of a 3-point GRE T1 method with built-in B1-correction (2) and SE sequence with protocol optimization based on 2-point measurements of T_2s (3) in the human SC at 3 T. The difference in T_1 values between our study and the literature (1) warrants further investigations.

References: (1) S. A. Smith, et al. MRM 60:213-219 (2008)**; (2)** R. Fleysher, et. al. MRI 26:781-879 (2008)**; (3)** R. Fleysher, et. al. MRI 26:433-435 (2008). **Acknowledgments:** This study was supported by NIH grant 5R01NS051623-04.