Regional brain T1 and T2 relaxometry in healthy volunteers using magnetic resonance fingerprinting

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Target Audience: Those interested in MR fingerprinting, relaxometry, advanced neuroimaging, and aging.

Purpose: To create a normative database of T_1 and T_2 of different brain regions using Magnetic Resonance Fingerprinting (MRF) and consider effects of age, gender and laterality on brain relaxometry.

Methods: In an IRB approved study, 50 healthy volunteers (M:F 22-28, age 11-72 years) were scanned on a 3T scanner (Siemens Skyra) using a standard 24 channel head coil. A True-FISP based MRF sequence was used to create quantitative T_1 and T_2 maps [1]. Scan parameters were: ST- 5mm, TR- variable, FA- 10 to 60 degrees, matrix size- 256x 256. About 4 to 5 slices were acquired per subject and a total of 40 different brain regions were assessed. Relaxation times for each brain region were measured by drawing ROIs (size 0.6 to 1.4 cm^2) on the parameter maps. The relationship between age, gender, laterality and relaxometry parameters (T_1, T_2) was analyzed using Pearson's correlation coefficient, independent sample t-test and paired t-test respectively. Based on previously published literature, relationship between age and relaxation parameters was tested using linear as well as quadratic fit models [2-4].

Results: T_1, T_2 of prefrontal, frontal and parietal WM increase with increasing age (left parietal T_1 p-value < 10^{-6}; PCC = 0.6 and T_2 p-value < 10^{-5}; PCC = 0.6) (Figure 1). Also in these regions quadratic model show a better fit as compared to linear model [Fig. 1]. T_1, T_2 measurements of occipital and temporal WM stay relatively stable with increasing age. There is significant age dependent decrease in T_1, T_2 of bilateral substantia nigra (Rt SN T_1 p-value < 10^{-4}; PCC = -0.54 and T_2 p-value < 10^{-3}; PCC = -0.40). No difference is seen with linear versus quadratic fit for SN. No significant changes are seen in T_1, T_2 of other deep nuclei. The age dependent changes were more pronounced in males compared to females in parietal WM and centrum semiovale. In right handed individuals, T_1 was significantly lower in right IC, right lentiform nucleus; and T_2 was significantly lower in right frontal WM and right lentiform nucleus compared to left side. There was significant difference between T_1, T_2 of medial versus lateral portions of bilateral thalami.

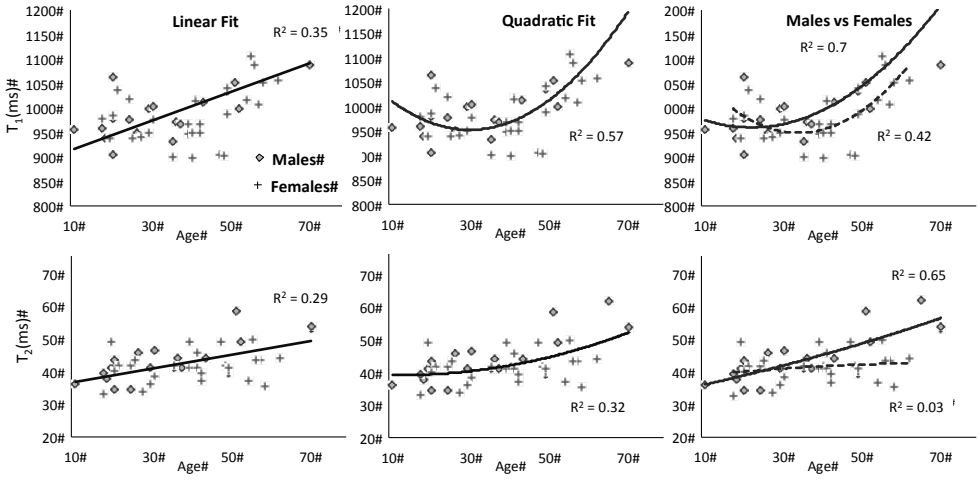

Fig1. MRF T_1 and T_2 relaxometry of left parietal white matter with a linear and quadratic fit in all subjects and quadratic fit in both genders separately (dashed lines - females).

Discussion: This is the first in vivo application of MRF in a large sample of normal volunteers. MRF based T_1, T_2 values of different brain regions agree with previously published literature [2, 5]. The age related relaxometry trends are also in agreement with previously published studies [2-4]. T_1, T_2 prolongation in higher age group seem to reflect microstructural changes such as increasing water content, demyelination, vacuolation and overall volume loss which are hallmarks of normal aging. The results also suggest that for certain brain regions, age dependent changes may be more pronounced in males as compared to females. MRF based normative T_1 & T_2 relaxometry values across a wide age span can serve as quantitative biomarkers for understanding physiological brain variations. A normative control database will also enable MRF based quantitative evaluation of neoplastic, demyelinating and degenerative diseases.

Conclusion: MRF allows simultaneous, rapid, in vivo quantification of relaxation parameters of brain. Analyses show significant differences in relaxation parameters of certain brain regions based on age, gender and handedness.

References:

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