Measurement of metabolites longitudinal (T1) and transverse (T2) values for absolute quantification by 1H-MRS in aging brain at 3Tesla

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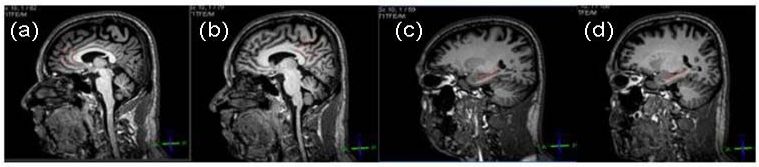
Objectives: T1, T2 relaxation times are essential correction factors when conducting absolute quantification in proton magnetic resonance spectroscopy (^{1}H-MRS). Only 2 studies investigating aging brain employed T1and T2 correction factors [1-2]. However, none of the above studies attempted to measure both T1 and T2 values within the sampling population. In this study, rather than relying on the literature, 5 younger subjects out of the 30 subjects (mean=49.87±18.33 years) in our aging study were selected to measure their corresponding T1 and T2 values of different metabolites and water in various brain regions at 3 Tesla.



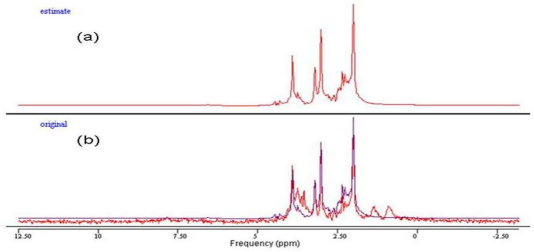
Positions of voxels placed: (a) anterior cingulate, (b) posterior cingulate, (c) left hippocampus and (d) right hippocampus

Material and methods: Experiments were performed on five cognitively normal (Mini-mental-state-examination ≥28) subjects (mean=24.4±1.95 years) using 3.0T MR scanner (Achieva, Philips Healthcare). 8-channel SENSE head coil was used. T1 relaxation time of various metabolites and water was measured using point resolved spectroscopy (PRESS) as method for volume selection and excitation method for water suppression. A series of 5 TR: 900, 1200, 2000, 3000 and 5000ms and TE=144ms single voxel spectroscopy (SVS) MRS were employed for metabolite T1 determination. Number of signal averages (NSA) for anterior cingulate (AC) and posterior cingulate (PC) is 64 and for left hippocampus (HC) and right HC is 32. For T2 relaxation times, PRESS and excitation were also employed. A series of 8 TE: 35, 60, 90, 120, 150, 180, 288 and 408ms and TR=2250ms SVS MRS were employed for metabolite T2 determination. NSA for AC and PC is 16 and for left HC and right HC is 32. Voxel size in both T1 and T2 metabolite determinations are 2x2x2cm^3 for AC and PC and 2.5x1.5x1cm^3 for left HC and right HC. NSAs for various regions were adjusted to achieve the best signal-to-noise ratio with reasonable time. The whole scan lasted for 90minutes. MRS data was analyzed with offline software jMRUI version 4.0 using quantification based on quantum estimation (QUEST). For calculation of T1 and T2 values of different metabolites, T1 values were obtained using non-linear regression of signal intensity versus TR. T2 values were calculated using exponential decay of signal intensity versus TE. T1 and T2 values of choline (Cho), creatine (Cr), N-acetylaspartate (NAA) and water were investigated in different limbic structures.

Results: The mean T1 and T2 values are expressed in milliseconds (ms).

(ms)	T1 $_{Cho}$	T1 $_{Cr}$	T1 $_{NAA}$	T1 $_{Water}$	T2 $_{Cho}$	T2 $_{Cr}$	T2 $_{NAA}$	T2 $_{Water}$
AC	1680±802	1925±496	2091±371	2353±112	271±51	142±23	267±28	116±10
PC	1545±534	1719±494	2066±189	2190±132	197±102	158±15	259±38	109±14
Left HC	1443±448	1808±482	2541±1744	2116±97	185±66	137±53	225±19	108±8
Right HC	1871±1159	2254±1388	2133±697	2071±193	263±117	154±34	201±25	104±15

Discussion: T1 and T2 values of various metabolites vary in different regions, performance of scanners and sequence designs. Compared to a study which used stimulated echo acquisition method (STEAM) as method for volume selection and inversion times (TI) for calculation, our measured T1 values of Cho, Cr and NAA are larger than that of reported in occipital grey matter (Cho 1300±60, Cr 1460±70, NAA 1350±120) [3]. In absolute quantification, correction factors for T1 and T2 are essential to accurate results. Sufficient time-points were used in our study to achieve a more accurate measurement of T1 and T2 values. This study shows that it is worthwhile and feasible measuring the T1 and T2 values within the sampling population. The amount of time taken is also reasonable and able to be withstood by subjects.



Spectrum of a subject's posterior cingulate, (a) estimate spectrum from jMRUI using Quest, (b) estimate spectrum(blue superimposed on original spectrum (red)

Reference:1. Brooks JCW, et al. Cerebral Cortex (2001) Jul 11:598-605, 2. Gruber S, et al. Eur J Radiol (2008) 68:320-327, 3. Mlynarik V, et al. NMR Biomed (2001) 14:325-331