Weekly Scanning of a Normal Control over Four Years

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Purpose: We present a longitudinal dataset in which five standard MRI acquisitions were acquired in a single volunteer on a weekly basis for approximately four years (162 acquisitions). There are numerous longitudinal studies that have followed patients or controls for long term (years) but typically acquisitions were performed only several times per year. There are also several studies that have followed patients or controls frequently (e.g., every two weeks) but only over a short period of time (~ 6 months, [1]). Therefore this dataset provides a unique view of a normal adult acquired weekly and over a long period of time (currently four years). This data will be useful to validate the use of these sequences for tracking changes in signal intensity over time in patient groups with subtle neurological disorders and for monitoring of treatment response.

Methods: All data was acquired on a 3T Achieva MRI System (Philips Medical Systems, Best, The Netherlands) using a 16 channel head and neck coil (Nova Medical). There were no hardware changes to either the scanner or the coil but there was a software upgrade (Jan 9, 2012). The volunteer was a 39 year old (at initial scan) right handed male volunteer with no apparent neurological medical conditions. Scans were scheduled for 11:30am every Thursday and 75% of the scans were on that time and day of the week. For every scan the volunteer was supine in the neurovascular coil and padding was placed around the head to minimize head motion. After a survey and SENSE reference scan there were six standard acquisitions: MPRAGE (3D T1 weighted, 1mm isotropic, 212 mm FOV, axial, 4m 55s), DTI (Multi-slice, 2.2 mm isotropic, 212 mm FOV, 32 gradient directions, b=700 s/mm2, 4m 51s), MTR (3D multishot EPI, 1.5x1.5x2.2 mm, 212 mm FOV, saturation 400 Hz, 620 degree, 1.5kHz off resonance, 1m 56s), FLAIR (multi-slice TSE, 0.83x0.83x2.2 mm, 212 mm FOV, IR 2.8s), dual echo T2W (multi-shot TSE, 1.1x1.1x2.2 mm, TR/TE1/TE2=4174/12/80ms, 3m 28s) and a resting state functional (described in a separate abstract). All data was registered to the first MPRAGE volume using CATNAP [2]. The WM, GM and CSF were segmented using the FSL FAST algorithm [3] from each MPRAGE volume. The FA and ADC were calculated from the DTI scan and the MT ratio was calculated in the standard way. Change in mean WM and GM FA, ADC and MTR (%) were calculated per month (30 day period) and a two-sided p-value was calculated for a hypothesis test whose null hypothesis is that the slope of the signal is zero.

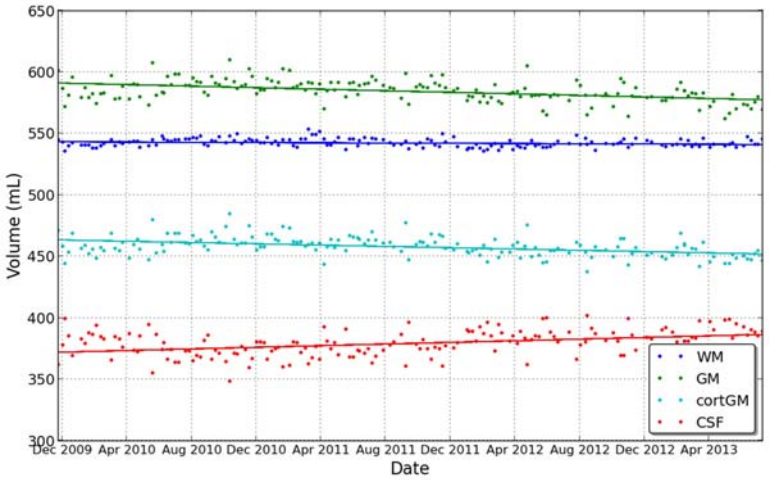

Figure 1: Relative signal intensity over the whole head acquisition as a function of time. Green bars represent one standard deviation from 100. The blue line is the linear regression of the data points.

Results and Discussion: Figure 1 shows the WM, GM, cortical GM and CSF volume (in mL) as a function of date. The WM volume was constant over the four years, while the total GM volume decreased linearly (0.30 mL/month decrease) as did the cortical GM volume (0.26 mL/month), which is consistent with the literature [4]. Figure 2 shows the average of the 162 MPRAGE and FLAIR scans relative to the first acquisition of each. Figure 3 shows the mean FA, ADC and MTR in WM and GM. Of these, the slope of the mean WM and GM ADC and the mean WM FA were statistically different from 0. The FA reduction, ADC increase and MTR reductions in GM are in line with the trends regarding reduced GM volume and increased CSF fraction as GM voxels always contain about 10-15% CSF. More analysis is required for a full understanding of this data.

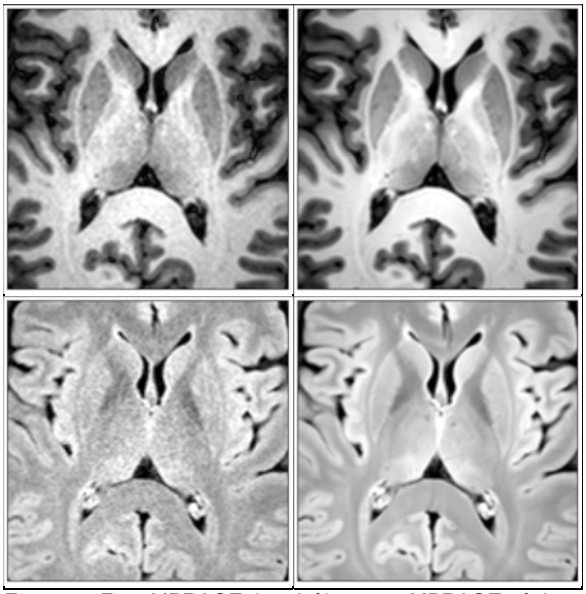

Figure 2: First MPRAGE (top left), mean MPRAGE of the 162 scans (top right), first FLAIR (bottom left), and mean FLAIR of the 162 scans (bottom right).

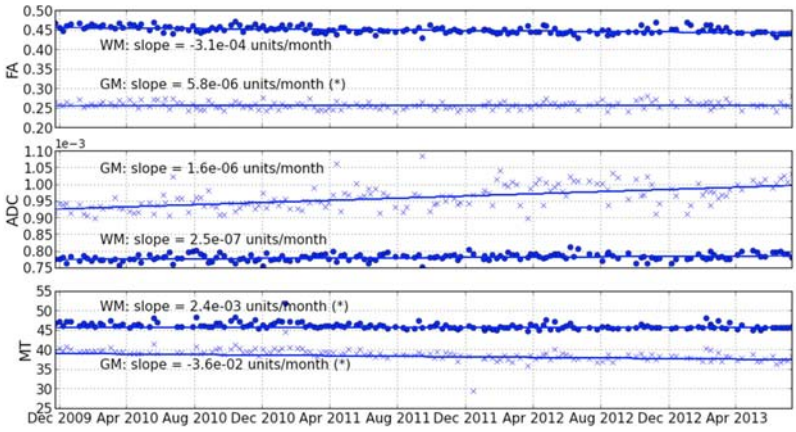

Figure 3: Mean WM and GM values for three derived measures. Those annotated with a * represent a slope not statistically different from 0.

Conclusions: The WM, GM and cortical GM volume changes were consistent with previous literature. Derived FA, ADC and MT changes in WM and GM were small over the four year period and were statistically significant for the ADC measure and WM FA. This dataset validates the tracking of volume changes over time to study disease progression or treatment effects.

Refs: [1] Willoughby et al., Annals of Neurology, v25(1):43ff, [2] Landman et al., Organization for Human Brain Mapping, Chicago, Illinois, June 2007, [3] Zhang et al., IEEE Trans Med Imag 2045ff, [4] Ge et al., Am J Neuroradiol 23:1327ff. Funding: NIH grants P41 EB015909