Fast mapping of absolute water content in the human brain using TAPIR

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Introduction

Water content in the human brain is highly regulated and influenced by various diseases such as brain tumours, stroke and hepatic encephalopathy [1-4].

We present a new method for fast and accurate high resolution mapping of *in vivo* water content in the human brain. The method is based on the TAPIR sequence [6-9] for M_0 mapping and QUTE[10] to correct for T_2^* relaxation effects. The proposed method employs the M_0 value of cerebral spinal fluid (CSF) as a reference to calibrate the watermaps. Thus, no additional reference probes are required.

Methods

All experiments were performed on a 3 Tesla Siemens Tim-Trio System (Siemens Medical, Erlangen, Germany). Water content mapping was performed on 9 healthy volunteers. A modified version of the known TAPIR sequence [11], with an adiabatic inversion pulse to reach better inversion efficiency and more accurate fitting results is used. Additionally, the inversion efficiency was measured with TAPIRie and passed to the fitting routine together with the TAPIR data to obtain M_0 data. These M_0 maps are influenced by T_2^* weighting due to the finite TE of the sequence and by receiver coil sensitivities.

These effects are corrected using quantitative T_2^* values calculated by means of QUTE and a unified segmentation algorithm to estimate the bias field which is implemented in SPM8[12,13]. The corrected M_0 map is calibrated to the H_2O value of CSF using the CSF peak of the histogram.

Sequence parameters:

TAPIR: TR=12ms;TE=5.6ms;EPI=5;TI=20ms;TAU=2400ms;20 timepoints; BW=720Hz/Px; resolution=(1x1x2)mm; 8 slices; acquisition time (TA): 2:50 min; TAPIRie: same as TAPIR but resolution=(2x2x2)mm; TA=0:40min; QUTE: TR=479ms; 1.TE=4.6ms; last TE=55ms; BW=260Hz/Px; resolution=(1x1x2)mm; 8 slices; 3 averages; TA=4:48min

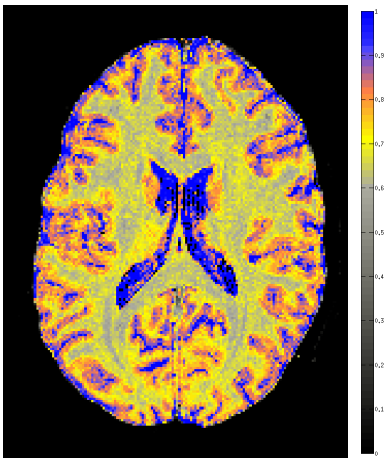
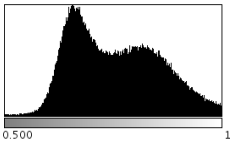


Figure 1: *In vivo* results: representative slice of an absolute water content map and histogram of the dataset



Results

Figure 1 depicts a representative slice of a water content map and a histogram. Averaged results of 9 healthy volunteers (male only, age 26±1) show water contents of (67±2)% and (83±2)% for white and grey matter respectively which is in good agreement to literature values [14-16].

Representative slices of all 9 healthy volunteers are shown in Figure 2. These maps do not show any receiver coil sensitive profiles. Inter subject variability between all subjects is small and values are in good agreement with values found in literature. The goal of quantitative measurements amongst other things is the reproducibility with different hardware. Since qMRI methods are prone to B_1^+ and B_1^- effects, a comparison of three different measurements using three different coils (CP Tx/Rx, 12 channel head-array and a 32 channel head-array) with one healthy volunteer was performed. The same protocol as stated above was used. In case of the CP coil parallel imaging was not possible and thus GRAPPA was not used. In this case the Tx/Rx coil was used for transmission of the signal as well. Results are presented in Table 1 and in good agreement with each other and with literature as well.

Discussion

It has been demonstrated that water mapping of the human brain without external reference probes and a resolution of 1x1x2mm is feasible in total acquisition times of 8:18min. Using parallel imaging techniques, it should be possible to further reduce the total acquisition time. The use of combined EPI and PI techniques for water mapping is under investigation.

	H2O (%) GM	WM
CP	80 ±10	66±4
PA	80±8	67±4
32ch	80±9	67±5

Table 1: H_2O values of a single subject measured with different receiver coils

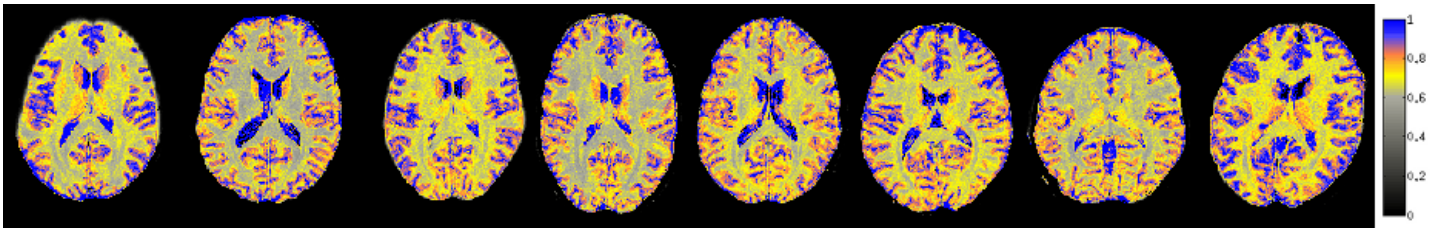


Figure 2: Representative slices of all 9 healthy volunteers.

References

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