Mapping of T_1 relaxation times using a 3D Variant of TAPIR

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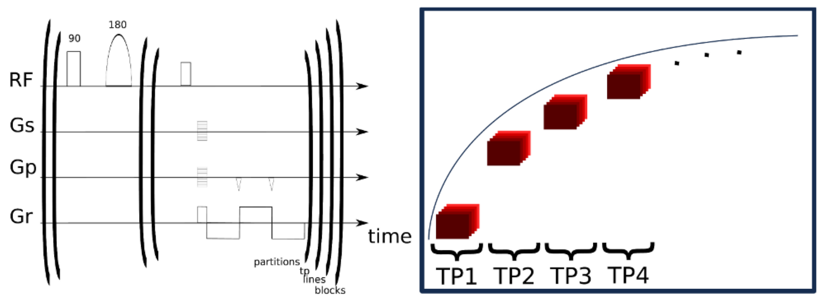
Introduction

Fast and accurate T_1 mapping of the human brain provides many opportunities for diagnostic use. For example, it has been shown that T_1 values differ in patients suffering from hepatic encephalopathy [1]. The TAPIR sequence [2-5] is a distortion-free and accurate method to acquire T_1 maps. Since slice thickness in 2D sequences is limited by the slice profile of the excitation pulse and SNR ([6]), it is desirable to have 3D imaging. A 3D T_1 mapping approach based on the TAPIR scheme is presented and investigated in phantom experiments as well as *in vivo*.

Methods

All experiments were performed on a 3 Tesla Siemens Tim-Trio System (Siemens Medical, Erlangen, Germany). T_1 mapping was performed on a healthy volunteer and a so-called “revolver phantom” comprising 8 tubes filled with distilled water doped with different concentrations of Gd-DPTA. For phantom measurements, TAPIR results were compared to gold standard spectroscopic inversion recovery measurements.

Using the TAPIR approach, after approximately 8 partitions sampled with 20 time points, the measured signal in *in vivo* applications does not change significantly anymore. To acquire more than 8 phase encoding steps another loop, called “block loop” (see Figure 1a) was introduced. Figure 1a depicts the sequence diagram with loop structures. Figure 1b sketches the partition loop inside the time point loop and illustrates how the time points are acquired on the relaxation curve. Parameters used were: TR=12ms, TI=10ms, EPI-factor=5, 20 time-points, block loop size: 8, 40 partitions, τ=2400ms, voxel size: 1x1x2.5 mm



T_1 [ms] (Spectroscopic)	T_1 [ms] (TAPIR 3D)	Difference [%]
390	403 ± 5	3
479	491 ± 7	2
627	606 ± 8	-3
688	689 ± 17	0
829	838 ± 17	1
848	824 ± 21	-3
1340	1345 ± 43	0
1861	1950 ± 168	5

Results

In phantom:

Table 1 presents results of a phantom experiment and a comparison to the gold standard spectroscopic inversion recovery. The measured T_1 values have a high accuracy.

In vivo:

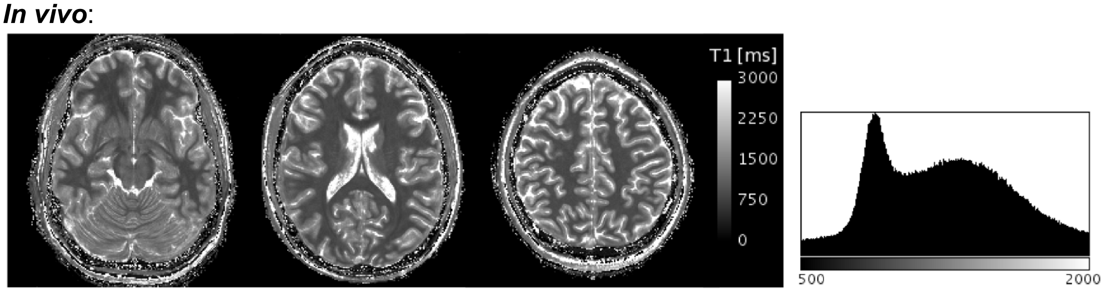


Figure 2 depicts representative slices of a whole brain T_1 map and a histogram, which presents two well-defined peaks for grey and white matter (863ms, 1332ms). These values are in good agreement with literature values at 3 Tesla. [8,9]

Discussion

It has been demonstrated that it is possible to use the TAPIR approach for a 3D T_1 mapping procedure with whole brain coverage in an acquisition time of 14:35 minutes plus 7:27 minutes for an inversion efficiency measurement. A more efficient sampling strategy for the use in inversion efficiency measurements is currently under investigation.

References

[1]Shah et.al.,Hepatology.2003;38(5):1219-26.;[2]Shah et.al. GermanPatentApplicationNumber:10028171.0;[3]Shah et.al.USPatent 6803762;[4]Steinhoff et.al.,MagnResonMed.2001;46(1):131-40.;[5]Shah et.al.,NeuroImage2001, 1175-1185;[6]Nishimura. Principles of magnetic resonance imaging.1996.;[7]Moellenhoff et.al., ISMRM2010:2581;[8]Wansapura et.al, JMRI, 9(4):531–538,1999;[9]Oros-Peusquens et.al., MagnResonMaterialsInPhysics,BiologyAndMedicine,21(1):131–147, 2008