Carr-Purcell-Meibom-Gill T2 mapping of prostate at 3 T.

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Introduction

In clinical MR examinations of the prostate, a multiparametric approach is becoming standard procedure, where data acquisition includes T1- and T2-weighted images, quantitative measurement of the apparent diffusion coefficient (ADC) of water, dynamic contrast-enhanced MRI following Gd-DTPA administration and measurement of the Cho/Cit ratio by chemical shift imaging. The combination of these parameters improves the specificity and sensitivity to detecting/monitoring disease [1]. In longitudinal studies it is often of interest to measure additional quantitative parameters, such as the T2 relaxation time [2-4]. The Carr-Purcell-Meiboom-Gill (CPMG) approach has recently been proposed for T2 mapping of the prostate at 1.5 T [5]. No such studies have been performed at 3 T. The present study investigated the CPMG approach for T2-mapping of the prostate at 3 T, in order to establish a clinical protocol for quantitative assessment of prostateT2 relaxation time.

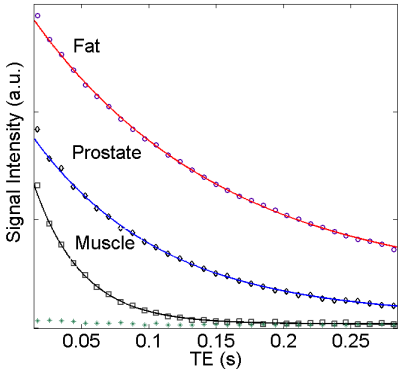

Fig1. T2 relaxation decays of fat, prostate and muscle adjacent to the prostate. The solid line indicates the monoexponential fit to the data

Materials and Methods

MR experiments were performed on a clinical 3 T Tim Verio Siemens scanner (Siemens Healthcare, Erlangen Germany) with a phased-array receiver coil, in healthy volunteers (n = 3). The vendor-supplied CPMG sequence consisted of optimized 180° sinc refocusing pulses, with spoiler gradients of constant amplitude applied around each refocusing pulse along the frequency-encoding direction. Two measurements were performed: i) a single slice acquisition (32-echo/8.8ms) for detailed T2 measurements, and ii) a multislice acquisition (8-echo/15ms) for T2 volumetric mapping of the prostate. In-plane resolution was 1x1mm, with a slice thickness of 4 mm.

	T2 (ms) 32 echoes	T2 (ms) 8 echoes
Prostate	95 (92-100)	115 (105-125)
Fat	141 (136-147)	111 (87-135)
Muscle	35 (34-36)	21 (8-33)

Table. T2 relaxation time of the prostate (peripheral zone), fat and muscle, measured with two CPMG sequences (left, TE = 8.8ms; right, TE = 15 ms). In parentheses, the 95% confidence intervals are indicated.

Results/Discussion

Accurate measurements of T2 relaxation decays require the acquisition of several echoes at very short echo spacings and a high signal-to-noise ratio (SNR). This is accomplished with a single-slice CPMG sequence (**Fig.1**), which reduces signal losses due to incidental magnetization transfer (MT) effects and MT bias on the T2 calculation [5].The 32-echo/8.8ms CPMG sequence provided detailed coverage of the T2 relaxation decay curve in prostate and surrounding tissues. The T2 value measured in muscle (**Table, left column**) is excellent agreement with previously reported values [6]. Prostate (peripheral zone) T2 value (**Table, left column**) observed in this study is shorter than the T2 measured at 1.5 T [5], in agreement with the expected functional dependence of the T2 on the magnetic field strength B_0 [6]. For clinical application, T2 mapping of the whole prostate volume is necessary. The T2 values measured with the 8-echo/15ms CPMG multislice protocol are only partly affected by the increased diffusion losses (muscle) or incomplete coverage of the decay curve (prostate, **Table, right column**).

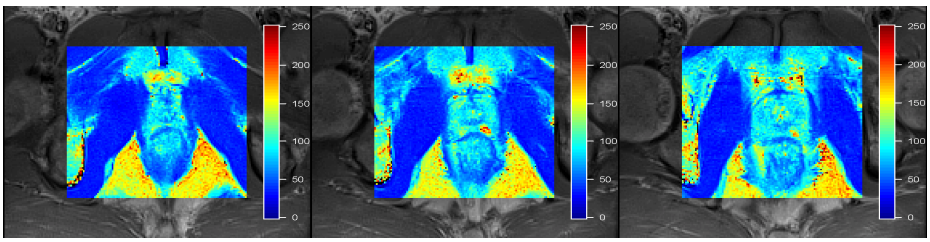

Fig.2. T2 maps of prostate at 3T (colorbar indicates T2: 0-250 ms), 5min scan time, 1x1x4mm^3 voxel size.

Overall, good quality T2 maps (TR of 2 s, 12 slices, **Fig.2**) can be obtained in 5 min scan time. By increasing the TR to 4 s, resulting in a 10 min scan time, it is possible to acquire up to 14-16 echoes in 14 slices (data not shown) to further improve the T2 assessment. Translating the CPMG sequence to 3 T is not straightforward and involves compromises in clinical implementation. Here we have shown high quality measurements of T2 may be obtained over the entire prostate by careful design of the clinical acquisition.

References [1] Fütterer JJ et al., Radiology. 2006;241:449-58. [2] Langer DL, et al., Radiology. 2008;249:900-8. [3] Gibbs P. Magn Reson Med. 2001;46:1054-8. [4] Storås TH, et al, J Magn Reson Imaging. 2008;28:1166-72. [5] Roebuck JR, et al., Magn Reson Imaging. 2009;27:497-502. [6] Gambarota G et al., J Magn Reson Imaging. 2009;29:982-6.