High Resolution T2 Mapping of Abdominal Organs at 1.5 Tesla: Normal Statistical Variations

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Introduction

While relaxation weighted imaging is the mainstay of almost all clinical MR scanning protocols, the use of high resolution parametric T_2 maps can be clinically relevant if reproducibly obtained within a reasonable scan time with statistically significant differences between normal tissue and pathology. The increased clinical value would be due to the more quantitative nature of the data presented. Recent studies have shown that T_2 can differentiate between benign and malignant liver conditions with simple mapping techniques.(1) In addition it has been shown that T_2 mapping of liver iron is shown to correlate with liver iron in a sickle cell patient population.(2) With this technique, T_2 data has also been shown to be useful for monitoring liver iron altered by chelation therapy.(3) Based on several technical evolutions in body MRI, simple Carr Purcell Meiboom Gill (CPMG) multi echo acquisition in conjunction with fat suppression, respiratory triggering, driven equilibrium, and SENSE can significantly improve the quality of MR mapping techniques. Higher system gradient strengths allow shorter initial echo times. Improved shimming reduces B_0 in homogeneity which facilities the use of fat suppression. With reduced signal intensity from fat, a simple bellows based respiratory triggering can be used to reduce overall motion artifacts. Driven equilibrium (DRIVE) pulses maintain a constant equilibrium magnetization. And, SENSE allows higher spatial resolution in shorter overall imaging time.

Materials and Methods

An IRB approved protocol was used for recruiting normal volunteer subjects. All MR data was acquired using a Philips 1.5 Tesla scanner (Philips Medical Systems, Best, NL) with a SENSE compatible array coils. Experimental T_2 maps were obtained using a fat saturated 5 echo CPMG respiratory triggered protocol with TR/TE/Flip angles; >2000msec / 20, 40, 60, 80, 100 msec /90-180 degrees. We were able to acquire 20, 5 mm slices with an in plane acquisition voxel size of 2.25 ,2.79 mm in 400 mm field of view at an imaging time of approximately 10 minutes (depending on respiratory cycle) with SENSE factor of 2. We used a Philips inline based software tool to calculate T_2 maps. Inter-subject data consisted of 5 different volunteers with one ROI in each tissue; intra-subject consisted of one ROI/organ on one volunteer scanned 5 different times; and intra-organ consisted of one subject with 5 different ROI's within a given organ system.

Results and Discussion

Figure 1 shows representative image quality for an abdominal T_2 map. There was reduced motion artifacts relative to other non-gated acquisitions. Table 1 shows inter and intra patient variability obtained from 5 samples as well as intra organ variability on one exam, all from normal volunteers at 1.5T. We used coefficient of variation as a metric for precision of the data. As expected the inter-subject CoV was higher for organ systems most likely due to heterogeneous population of normal volunteers.

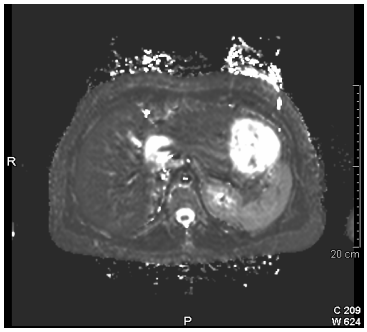

Figure 1. T_2 map showing abdominal organs

	Inter-subject (mean ±sd/CoV)	Intra-subject (mean±sd/CoV)	Intra-organ (mean±sd/CoV)
Liver	51± 5.4 / 10.7	61 ± 1.8 / 2.9	46.4 ± 3.26 / 7.04
Spleen	102 ± 16 / 15.1	102 ± 4.4 / 4.3	92.46 ± 6.95 / 7.5
Muscle	34 ± 2.6 / 7.6	33.5 ± 2.1 / 6.4	31.56 ± 1.88 / 5.94
Kidney	105 ± 9.6 / 9.1	113±/ 9.6 / 8.5	96.64 ± 5.12 / 5.30

Table 1. T_2 values obtained with five echo CPMG ,triggered acquisition.

In order to have statistically significant T_2 correlations for various pathologies requires acquisition strategies with high precision. Our T_2 data correlates well with published data at both field strengths with this triggered CPMG technique and the precision evaluated using coefficient of variation for intra-subject variability is acceptable. The standard deviations in these T_2 regions suggests that the sensitivity using this technique is 0.2 mg/gm of Hepatic iron concentration using the linear regression from previous work(2).

References:

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