Quantitative Measurements of T1 and T2 for the Abdomen in a 3 Tesla Whole-Body Imager

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ABSTRACT

A 2-D gradient echo spiral sequence was used to generate T1 and T2 image sets in the abdomen of healthy volunteers at 3T using Look-Locker and T2-prep techniques respectively. Relaxation times were calculated by fitting signal magnitude to a monoexponential decay using a least squares fit. Range of T1 and T2 values at 3T were compared to 1.5T values found in the literature. As expected, T1 values at 3T increased with respect to T1 values at 1.5T. T2 values remained largely unchanged. The results can be used to optimize abdominal imaging at 3T by allowing for better tissue structure differentiation.

INTRODUCTION

Studies have shown that the overall quality of an MR image is dependent on many factors including contrast-to-noise ratio (CNR), signal-to-noise ratio (SNR), spatial resolution, and artifact level. Imaging at higher field strengths is attractive because of the potential for higher SNR, CNR, and resolution or shorter imaging time. Recent availability of whole body 3T makes it now feasible to image at a higher magnetic field strength than at the commonly used 1.5T. Relaxation times (T1 and T2) values have been well established for many tissues at 1.5T but have not been as well established for 3T. Measured T1 and T2 values for upper abdominal organs at 3T are limited in the literature. The purpose of this study is to calculate T1 and T2 values for liver, spleen, kidney cortex, pancreas, and muscle at 3T in order to develop a method for optimizing abdominal imaging at this higher magnetic field.

MATERIALS AND METHODS

Healthy volunteer subjects (2 females, 4 males) ranging from 26-30 years old participated in this study. Informed consent per approved IRB protocol was obtained prior to each examination. Experiments were performed on a 3T whole-body scanner (GE, Signa) using a four-element torso phased array coil for signal reception. To decrease motion artifact, the study was carried out with an approximately 40 second breath hold. To maintain constant resolution and SNR, the field of view was kept at 40 cm regardless of patient girth. The effective resolution was 3.54 mm and the section thickness was 5 mm. Sets of images in a single axial plane through the liver, kidney cortex, and pancreas in one slice and through the liver and spleen in another were acquired for measurements of relaxation times.

A Look-Locker (1) sequence was used to obtain image sets for the T1 calculations and a T2-prep (2, 3) sequence was used to obtain image sets for the T2 calculations. A 2-D gradient echo spiral with continuous power monitoring was used to acquire these image sets. The prescription parameters are as shown in Table 1.

Parameters	T1	T2
Number of Echoes	8	4
TR	2000 ms	1000 ms
TE of gradient echo acquisitions	200 ms	6 ms
Flip Angle	10°	90°
BW	125 kHz	125 kHz
Points for each acquisition	4096	4096
Spiral arm	3	3
NEX	4	2

Table 1: Prescription parameters used to generate image sets for T1 and T2 quantitation.

Xcinema (Stanford University) was used to process the acquired images to obtain T1 and T2 values by fitting the signal magnitude from the region of interest (ROI) in the image sets as a monoexponential decay in a least squares fit (4).

RESULTS

Relaxation measurements were obtained for liver, kidney cortex, spleen, pancreas, and muscle of healthy volunteers. The T1 and T2 values are given in Table 2. Compared to the 1.5T values reported in the literature (5, 6) for these different tissues, the T1 values are longer at 3T. This is not surprising given that previous studies have shown that as field strength increases, T1 likewise increases (5, 6). T2 values, however, have been demonstrated in prior studies to be roughly unaffected by field strength (5, 6). As expected, T2 values at 3 T were similar to those obtained at 1.5T.

Tissue	T1	SD	T2	SD
Liver	989.6	40.9	38.8	3.6
Kidney Cortex	1580.5	122.2	88.0	11.4
Spleen	1514.6	74.5	65.0	9.2
Pancreas	986.8	51.9	50.3	3.1
Muscle	1484.9	72.1	32.4	5.9
NOTE: SD = standard deviation				

Table 2: T1 and T2 measurements (in milliseconds) at 3 Tesla.

DISCUSSION AND CONCLUSION

As the trend moves toward imaging at higher magnetic field strengths, having available measured T1 and T2 values for different tissues will be critical to optimize pulse sequence parameters. The abdomen has been a particularly difficult region of the body to image due to several factors including motion and variable iron content. We have successfully measured T1 and T2 values for liver, kidney cortex, spleen, and pancreas at 3T.

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