Examining Myocardial Tissue Properties with 3T MRI

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INTRODUCTION

High field MR scanners, high resolution scans, and modern image reconstruction algorithms can provide unique information about myocardial tissue properties not previously available. It is hoped that these new tools will allow researchers to detect subtle changes in the heart to yield new insight into basic questions about cardiac physiology and foster inquiry into cardiac pathology. Of particular interest is the possibility of using 3T high-resolution scans to determine tissue property variations in individuals with heart failure with preserved systolic function, also known as diastolic dysfunction. Currently there is no gold-standard test for this condition that may comprise up to 1/3 of all heart disease. Towards this goal, we developed breath-hold scan protocols to measure T2 and T2* in the myocardial septum at 3T.

METHODS

This methodology was investigated on seven healthy volunteers. Subjects were imaged using a 3.0T Philips Achieva MR scanner with a six-channel cardiac imaging coil. Short axis images were acquired using cardiac triggering, breath-hold motion suppression, and black-blood preparation.

T2 values were obtained via two methods. The first involved acquisition of a series of 5-7 dual-echo, turbo spin-echo scans. Echo times were spaced approximately 15ms apart over a range from 15ms to 105ms. The second method used a single 8-echo, turbo spin-echo sequence. Common scan parameters were: TR = 1 RR interval, FOV = 286 x 300 mm, matrix 256 x 183 interpolated to 256 x 256, slice thickness = 4mm, flip angle = 90, half-scan = 0.6, SENSE factor = 1.5.

T2* values were obtained using a series of 5-7 dual-echo, gradient-echo sequences. The first echo was fixed at 2.3ms and second echoes were incremented in-phase to 20ms or until SNR dropped below 10. To counter effects of system drift, signal intensities for each echo were normalized based on comparison of the 2.3 ms echoes. Relevant scan parameters include: TR = 25-30ms, flip angle = 25°, FOV and matrix were the same as for T2 scans.

Signal values were taken from regions of interest (ROIs) in the ventricular septum to compute T2 and T2* by fitting the data to a monoexponential decay curve. In the case of map generation, each pixel served as an ROI.

RESULTS

T2 for the ventricular septum was 57.5 ± 3.5 ms (N=4) with R^2's from 0.987 to 0.988 for the monoexponential fits. A first echo SE image is given in Figure 1a. A map of T2 in another subject is given in Figure 1b; this was created via the second T2 measurement method. By performing this 8-echo scan in a single breath hold, registration and motion artifacts were minimized. T2* for the ventricular septum was 17.5 ± 3.3 ms (N = 3) with R^2's of 0.966 to 0.994 for the monoexponential fits. A first echo GE image is given in Fig. 1c.

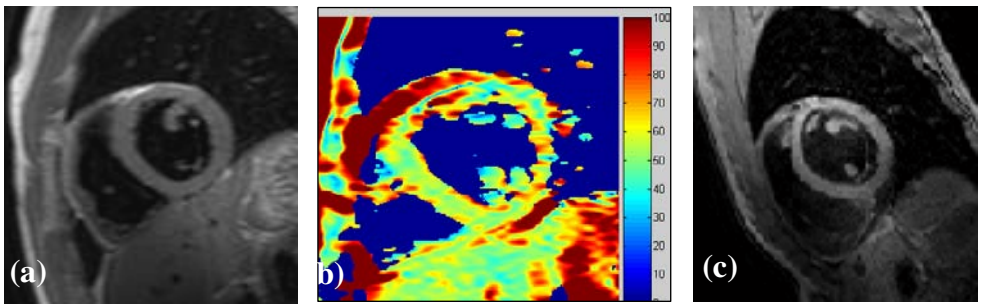

Figure 1: (a) myocardial spin echo image (b) T2 map (ms), (c) gradient echo image.

DISCUSSION AND CONCLUSIONS

There is a paucity of published T2 and T2* values in the myocardium at high field (≥3T), a problem remedied by this ongoing work. Other measurements reported somewhat shorter values for T2 (*in vivo* T2 = 41 ms for N=1[1] and *in-vitro* T2 = 47± 11ms[2]) and comparable values for T2*[3]. By isolating a methodology to return consistent values, research can move forward towards tying physiological, and eventually pathological, conditions to changes in T2 and T2* including studies of the myocardial BOLD effect.

REFERENCES (1) Schar et al, Magn Reson Med 2004; 51:799-806, (2) Stanisz et al, Magn Reson Med 2005; 54:507-512, (3) Noeske et al, Magn Reson Med 2000; 44:978-982.