Absolute Metabolite Quantification by Magnetic Resonance Spectroscopy Imaging in Skeletal Muscle: First Results and Reproducibility

X. Wang[1], L. Fayad[1], and P. Barker[2]
[1]Johns Hopkins University, Baltimore, Maryland, United States,
[2]Radiology, Johns Hopkins University, United States

Introduction

While multi-voxel proton magnetic resonance spectroscopic imaging (MRSI) is an established technique in the brain[1], it is only in recent years that MRSI has been used in the musculoskeletal system, for instance to study lipid concentrations in human skeletal muscle (calf muscles [2,3]). The main advantage of MRSI over single voxel acquisitions is its ability to simultaneously record spectra from multiple regions of interest, and to study intra-lesion variations. This study employs the phantom replacement method with phased-array coils [4] for the measurement of choline concentration, an important metabolite for malignancy characterization and the evaluation of treatment response [5]. The purpose of this study is to establish the reproducibility MRSI for determining Cho concentration in vivo in multiple human skeletal muscle groups.

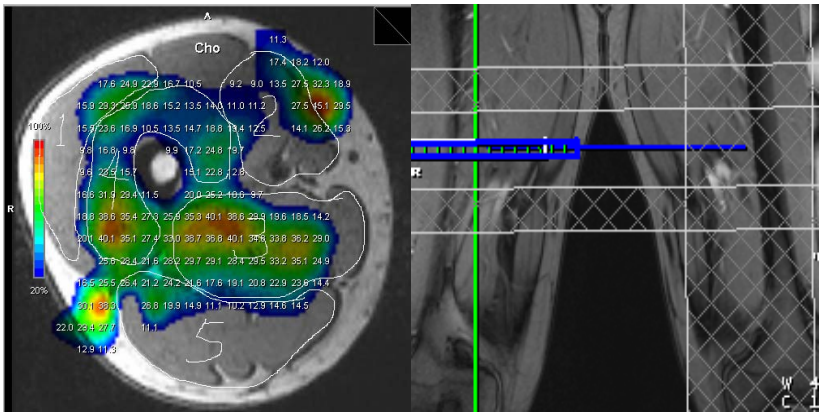

Figure 1: Axial view of color rendered anatomic image together with coronal view of collection location. Automatic quantification result of MRSI. The 5 regions of muscle were marked by numbers. The color map indicating 20% as blue to 100% as red for maximal Cho integral values were overlaid on top of the axial anatomic image of the thigh muscles. Concentration measurements incorporated the water integral values obtained by phased array and body coil collections.

Methods

PRESS-MRSI (TR 1800 ms, TE 135 ms) was performed to analyze muscle metabolite concentrations in a 25 year old healthy female volunteer using a 3T magnet (Trio, Siemens, Malvern, PA). An axial slice was chosen at the mid-thigh level for both legs, for two scanning sessions, 2 months apart, as in figure 1. MRSI voxel size was 1x1x1 cc. In-plane PRESS excitation was set to 10x10 cm, covering most of the major muscle groups. The spectral acquisition included water suppressed and unsuppressed collections using a body coil as transmitter and phased-array coil as receiver, followed by water unsuppressed collection using the body coil as both transmitter and receiver. The loading of the phased-array coil was estimated by the reciprocity theorem. The same procedure was applied to a N-acetylaspartate phantom consisting of 69 mM to estimate the in vivo metabolite concentrations [3].

Region with Date	Right 8-12-10	Right 10-11-10	Left 8-12-10	Left 10-11-10
1	4.4 ± 1.4	3.5 ± 1.6	5.1 ± 0.6	5.6 ± 0.9
2	2.8 ± 0.4	2.0 ± 1.0	4.9 ± 2.6	3.5 ± 1.8
3	4.9 ± 1.3	4.2 ± 1.4	6.1 ± 0.8	11.4 ± 4.5
4	2.5 ± 1.2	3.1 ± 1.2	4.9 ± 0.3	3.9 ± 2.0
5	2.4 ± 0.6	5.9 ± 1.8	3.1 ± 0.6	4.4 ± 1.1
Mean ± std	3.4 ± 1.1	3.8 ± 1.4	4.7 ± 1.1	5.7 ± 3.3

Table 1: MRSI Cho concentration measurements (mmol/kg) with the phantom replacement method, performed in 5 thigh muscle groups (outlined in Figure 1), show good agreement between acquisition sessions at 2 month intervals. Differences in concentrations may be due to variation of voxel locations and shimming conditions, or potentially physiologic factors.

Results

The MRSI data was processed using software provided by the manufacturer. After Hanning filtering, Fourier transform and automatic phase correction, the spectral data were fitted to a Lorentzian function. Figure 1 shows a color overlay of the Cho integral for one scan. The mean and standard deviation of the choline concentrations are listed in table 1. The Cho concentrations were similar in the 5 regions for both legs.

Conclusions

This study demonstrates that regional absolute quantitation of muscle Cho is feasible using 3T MRSI within clinical acceptable scan times (25 minutes).

Reference

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