Assessment of Bone Marrow and Muscle Lipids in Acromegaly Using ^{1}H Magnetic Resonance Spectroscopy

Hamed Mojahed[1], Pamela Freda[2], Christina Read[3], Alex Dresner[4], Truman R Brown[5], and Fernando Arias-Mendoza[3]

[1]Department of Biomedical Engineering, Columbia University, New York, NY, United States, [2]Department of Medicine, Columbia University, [3]Department of Radiology, Columbia University, [4]Philips Healthcare, Cleveland, OH, United States, [5]Center for Advanced Imaging Research, Medical University of South Carolina, Charleston, SC, United States

Purpose:

Studying lipids non-invasively using magnetic resonance spectroscopy (MRS) has been an area of interest in many clinical research studies [1-2]. According to the literature, for healthy male volunteers there is a correlation between total intra-myocellular lipid (IMCL) concentration estimated by MRSI of the muscle with vegetable oil as the external reference and MRSI of the muscle with bone marrow lipids as the internal reference [3]. We examined this by the means of single voxel spectroscopy and compared the IMCL normalized to the total lipids in the diaphysis with the IMCL normalized to total water in the same voxel for a group of acromegaly patients. We could replicate these results for most patients except for those suspected of having a muscular degenerative disease.

Outline of Content:

Fourteen acromegaly patients (9M/5F, 45±15 years of age, the oldest being 77 yo) were studied in a 1.5T MR scanner (Achieva, Philips Healthcare, the Netherlands) Water suppressed (WS) and Non-water suppressed (NWS) single voxel ^{1}H MRS (by applying point resolved spectroscopy (PRESS) technique) of the tibialis anterior (TA) and the diaphysis were acquired. MRS was acquired using a Knee-Foot coil with the following parameters for the TA: voxel size=15x15x45 mm^3, TR/TE=2000/40 ms, spectral bandwidth=1000 Hz, samples=512, averages=40, water suppression=Excitation (window=80 Hz, second pulse angle=300), duration=1:24 min. Axial T1W anatomical images were acquired for localization purposes. The PRESS box for MRS of the left diaphysis was positioned 80 mm superior to epiphyseal plate with similar parameter to the TA except: voxel size=15x15x15 mm^3, TE=144 ms, and only NWS data were acquired. T1-weighted images in three planes were also obtained. The NWS spectrum was phased, frequency shifted, and the water peak at 4.67 ppm was fitted with a Gaussian peak (3 baseline terms and 90% characteristics) using Philips's advance spectroscopy analysis package. The methyl (-CH_3) and methylene (-CH_2) groups were quantified in NWS spectrum of the diaphysis. For statistical analysis a regression model was performed.

Results:

The IMCL normalized to the total lipid in diaphysis correlated strongly with IMCL normalized to internal water in our patient cohort (Fig 1.A). If we exclude one patient suspected to have muscular dystrophy (Fig 1.B) the result is more realistic (R^2 = 0.89, $p < 0.00001$). This shows that methyl and methylene groups in diaphysis can be used as normalization factors in hydrogen MRS quantification of muscle spectrum in mixed sex cohort of acromegaly patients. In the study of muscle lipids and other metabolites, normalization to total muscle water is challenging for patients with muscular degenerative diseases as the water content in some muscle groups may be different than others.

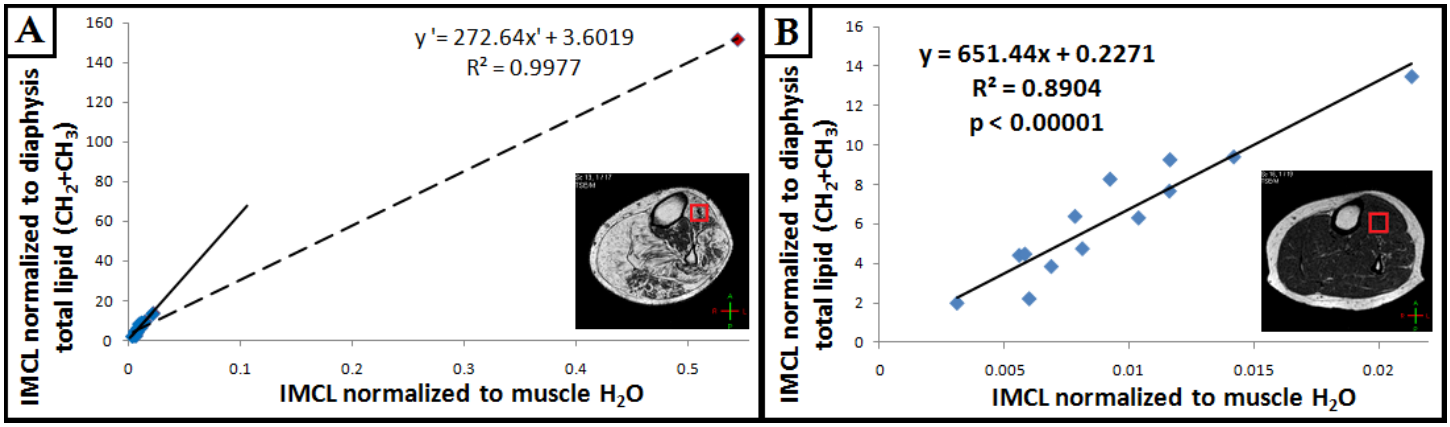

Figure 1: IMCL normalized to diaphysis lipid correlates (dashed line) with IMCL normalized to muscle water for acromegaly patients (n=14) including one patient (outlier) suspected of having a muscular disease (A). Removing the outlier, the rest of the patients still show linear correlation (solid line, B). The axial T_1W image of the muscle clearly shows the amount of muscle and subcutaneous lipids for the one outlier in A and in most of regular patients in B.

Summary:

In our study the IMCL/H_2O correlated with IMCL/(diaphysis lipid). This supports the prior results to use bone marrow as the reference region in muscle MRS quantifications [3], even in a mixed sex group of patients. However care is needed when examining the patients with muscular degenerative diseases.

References:

1. Korteweg, M. A. et al. J Magn Reson Imaging 2011 Oct 3;doi: 10.1002/jmri.22820.
2. Cheung, J. S. et al. Acad Radiol 2011 Mar;18(3):377-83.
3. Weis J. et al. Magn Reson in Medicine 2008;59:1259-1265.