

Assessment of Subchondral Bone Marrow Lipids in OA Patients at 3T

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Introduction Proton MR Spectroscopy (MRS) can provide a non-invasive method to quantify biochemical or metabolic changes in various diseases. MR spectroscopic imaging (MRSI) allows the examination of the spatial distribution of the metabolic levels (1). Although previous studies have used the MRSI method to measure the major components of the bone marrow signals including water and lipids (1, 2), there have been no quantitative assessments of bone marrow lipids alone in different compartments of femoral-tibial bone in osteoarthritis (OA) patients at 3T. Therefore, the goal of this work was to quantify the compartment-specific lipids changes in femoral-tibial bone of OA patients at 3T.

Methods OA subjects (K-L2, n = 11, 4 females, 7 males, mean age 62 years \pm 5.6 years, age range = 51-65 years) were scanned at 3T clinical MR scanner (MAGNETOM Trio, Siemens Medical Solutions, Erlangen, Germany), and an 18-cm diameter, transmit-receive quadrature knee coil was employed for all spectroscopy measurements of subchondral bone marrow lipids in four different compartments of femoral-tibial bone (LF, LT, MF, MT). Representative single voxel locations are shown in Fig. 1(a) (femoral bone) and Fig. 1 (b) (tibial bone). All MRS data were obtained using the single-voxel stimulated echo acquisition mode (STEAM) pulse sequence (TE=20 ms, TR=2000 ms, bandwidth=2000 Hz). The MRS data were processed with the Java-based Magnetic Resonance User Interface (JMRUI) (3) software using AMARES (Advanced Method for Accurate, Robust and Efficient Spectral) (4) time domain fitting procedure. The olefinic peak at 5.35 ppm, the methylene peaks at 1.3 ppm and 2.07 ppm and the methyl peak at 0.9 ppm were fitted with Lorentzian line shapes and unconstrained parameters.

Results and Discussion Saturated lipid signals in different compartments of femoral-tibial bone marrow are shown in Fig. 2 with the peak at 5.3 ppm used for normalization. The normalized saturated lipid signals for the frequency shifts of 0.9 ppm, 1.3 ppm, and 2.03 ppm were 0.85 ± 0.18 , 6.17 ± 0.88 , and 1.01 ± 0.06 in LF, 1.25 ± 0.32 , 7.73 ± 0.36 , and 1.44 ± 0.08 in LT, 1.13 ± 0.19 , 6.92 ± 0.37 , and 1.04 ± 0.05 in MF, and 1.18 ± 0.22 , 7.55 ± 0.25 , and 1.63 ± 0.14 in MT, respectively. Fig. 3 shows the unsaturated index of lipid in different compartments using the same calculation method as in Ref (2). The unsaturated indices were 13.25 ± 2.37 , 8.81 ± 0.21 , 10.22 ± 0.68 , and 8.87 ± 0.23 in LF, LT, MF, and MT compartment of femoral-tibial bone marrow, respectively. For the 2.03 ppm frequency shift, the differences in saturated lipid signal between: LF and LT, LF and MT, MF and MT, MF and LT were all statistically significant ($P < 0.002$ for all). For the unsaturated index, differences between: LF and LT, LF and MT, MF and MT, MF and LT approached statistical significance ($P < 0.11$ for all).

Conclusion In this work, we quantified compartment-specific lipid changes in femoral-tibial bone of OA patients at 3T. Both medial and lateral compartments of the tibia have higher saturated lipids compared to the medial and lateral compartments of the femur. The femur has a relatively higher unsaturated lipid index compared to tibia. This technique could prove useful in future studies to characterize bone marrow lesions in OA subjects.

References 1) Li X et al, J Magn Reson Imaging. 2008; 28: 453-461. 2) Yeung D et al, J Magn Reson Imaging. 2005, 22: 279-285. 3) <http://www.mrui.uab.es/mrui/mruiHOMEpage.html>. 4) Vanhamme L et al, J Magn Reson. 1997, 129:35-43.

