In Vivo J-Difference Lactate Editing at 3.0 Tesla

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Introduction: Multiple studies have indicated that lactate in tumors may predict metastatic disease and reduced survival (1,2). Because lactate is MR visible, it has the potential to be a non-invasive prognostic marker in human tumors. The goal of this study was to implement *in vivo* detection of lactate by ^{1}H MRS at 3 Tesla for potential applications in patients. BASING editing for lactate detection at 1.5T has been demonstrated in tumors (3) and proof of principle at 3T has been demonstrated in metabolite phantoms (4). The current study extends the previous work by testing the sequence in the presence of high lipid concentrations *in vivo* at 3T.

Materials and Methods: All scans were performed on a GE Signa 3T human scanner. Pulse sequence development was done with the 11X research environment. The sequence was constructed by inserting a 30ms BASING waveform, originally derived from the SLR algorithm, into a PRESS pulse sequence. The result consisted of a traditional PRESS scheme with an additional 180° pulse, flanked by bipolar gradients, embedded after each PRESS 180°. The sequence was modified so that the center of the BASING inversion band was alternated between +65 Hz relative to water (cycle 1) or -50 Hz relative to water (cycle 2) on consecutive passes. Therefore, the lactate methine quartet (4.1 ppm) was either unperturbed or inverted in consecutive cycles so that summation of consecutive cycles provided spectra of uncoupled metabolites, while subtraction of cycles produced lactate methyl spectra.

A normal volunteer was studied to demonstrate the effectiveness of the editing sequence *in vivo*. A blood pressure cuff was positioned just below the knee of a prone subject with his calf in a clinical knee coil, inflated, and the first J-difference scan immediately commenced. Each scan was 1m 18s with 11 scans performed. Parameters were: TE/TR 144/1500 ms, 32 transients (16/cycle,), 1.9 cm^3 voxel, 5 kHz spectral width, 2 k data points, and CHESS water suppression. As it is well known that [lac] detected in a PRESS voxel is influenced by chemical shift effects, we used a phantom to test over-prescription of the PRESS volume combined with spatial saturation of the voxel border regions to mitigate the chemical shift-induced variations in lactate modulation (5,6).

Results: Fig. 1 contains edited spectra from the calf muscle after blood flow restriction. The addition spectra indicate the level of muscle lipid, while the subtraction spectra indicate successful lactate editing in the presence of lipid. Figs. 2A and B contain phantom spectra obtained with standard PRESS voxel prescription at TE values of 144 and 288. The inverted lac at TE 144 has lower amplitude than lac at TE 288, demonstrating loss of net voxel signal due to chemical shift effects (the aberrant modulation effect is much less at TE 288). When voxel over-prescription with saturation of border regions was used (Figs. 2C and D), the TE 144 lac signal approaches the expected amplitude.

Discussion: The results demonstrate the ability of the BASING J-difference technique to detect lactate in the presence of strong lipid signals at 3T. This technique should permit non-invasive lactate measurements in human tumors in order to investigate its potential as a prognostic indicator.

Figure 1

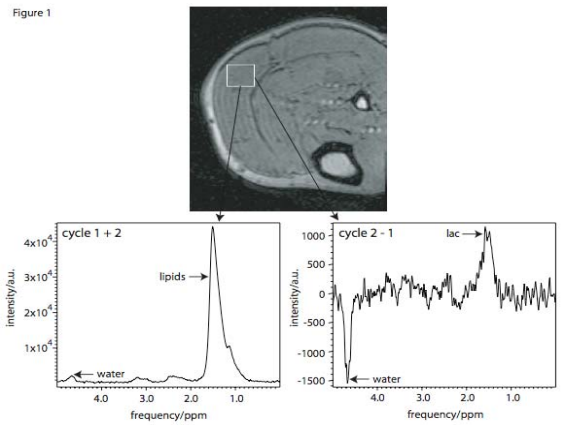
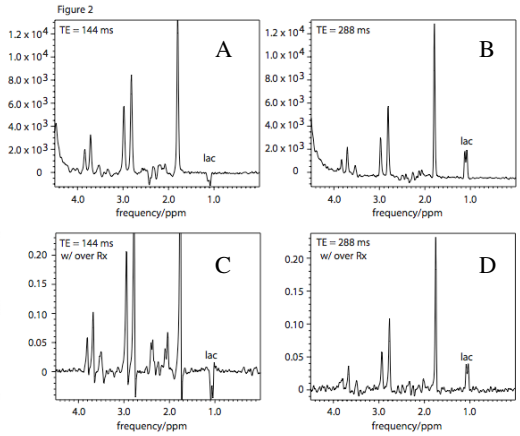


Figure 2



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