Abstract 45431

Signal enhancement of Glycogen by 13C NMR spectroscopy using broadband 1H decoupling and NOE at 7T

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Purpose / Introduction

^{13}C MRS is a powerful tool for investigating metabolism in-vivo, allowing non-invasive measurements of tissue Glycogen in human muscle [1]. The challenge of ^{13}C MRS on human scanners at high field is the implementation of ^{1}H-decoupling and NOE [3] while respecting the IEC guidelines for SAR. In particular, the Waltz16 [2] ^{1}H-decoupling scheme provides broader bandwidth relative to continuous wave (CW). Therefore, the aim of this study was to explore the feasibility of using Waltz16 decoupling in-vivo at 7T and to evaluate the signal enhancement of Glycogen and Glucose using Waltz16 decoupling and NOE in-vitro.

Subjects and Methods

All experiments were performed on a 7T human MR-scanner (Siemens Erlangen/Germany). A ^{13}C-^{1}H RF surface coil was built, consisting of a quadrature ^{1}H coil and a linear ^{13}C coil [4]. In-vitro experiments were performed using a two-compartment phantom: 800mM solution of glycogen (inner compartment) and 8mM solution of 1-^{13}C glucose (outer compartment). A pulse-acquire sequence with adiabatic half-passage excitation (2050µs) was implemented together with Waltz16 and CW ^{1}H-decoupling, and NOE. The decoupling duration and voltage required to achieve broadband decoupling were calibrated in-vitro for Waltz16 and CW schemes. NOE was calibrated and applied in-vitro. All in-vitro experiments were obtained with the following parameter settings: vector size=2048, BW=10 kHz, TR=8060ms, and 64 averages. In-vivo glycogen experiments were performed on human calf using Waltz16 (21ms decoupling duration), vector size=2048, BW=20 kHz, TR=2650ms and 256 averages (Figure1).

Results

The bandwidth of Waltz16 was measured in-vitro, to be 600Hz (10 times of that for CW) (Figure2). The duration of the Waltz16 scheme was adjusted for efficient glycogen and glucose decoupling. The glycogen peak was decoupled by applying 21ms decoupling (Figure3.a), whereas 87ms was required for glucose-α and glucose-β peaks (Figure3.b). The signal enhancement obtained using NOE in-vitro was 1.6 for glycogen, 2.5 for glucose-α, and 2.1 for glucose-β (Figure4).

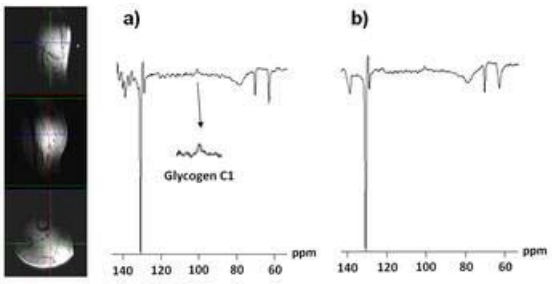

Figure 1: ^{13}C natural abundance signal of glycogen in human calf obtained by pulse-acquire with a) Waltz16 and b) CW decoupling (TR 2650ms, acquisition time 102ms, decoupling time 20ms, 256 averages and vector size 2048).

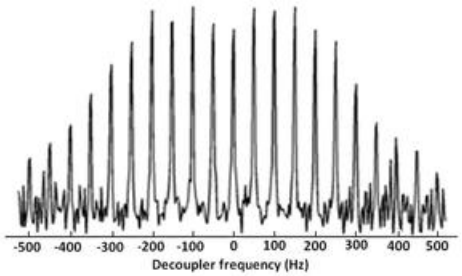

Figure 2: Decoupling bandwidth for Waltz16 measured in vitro by applying the sequence at a range of offset frequencies. Decoupling time = 87ms, TR=3s, BW=20 kHz, acquisition time=102ms, vector size=2048. The bandwidth was evaluated by measuring the frequency range within 80% of the peak height on-resonance, resulting of 600Hz.

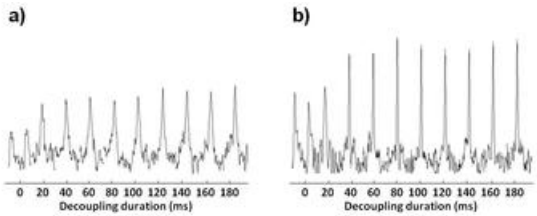

Figure 3: Calibration of the decoupling duration for Glycogen (a) and Glucose beta (b) using Waltz16 at a range of 10% steps of the total acquisition time (i.e.204ms). Glycogen was decoupled at 21ms, whereas Glucose alpha and beta required 87ms decoupling duration.

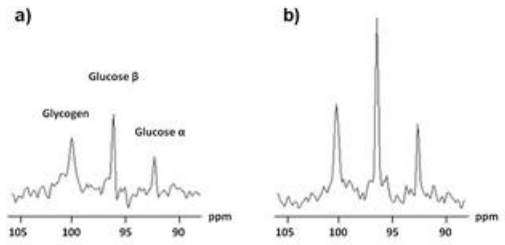

Figure 4: In vitro ^{13}C MRS of Glycogen and Glucose obtained by pulse acquire with Waltz16 (decoupling time = 87ms), TR=8060ms, BW=20 kHz, acquisition time=102ms, vector size=2048, (a) with no NOE, (b) with NOE (44 pulses of 1ms duration and 100ms pause). The enhancement obtained using NOE was 1.6 for Glycogen, 2.5 for Glucose alpha, and 2.1 for Glucose beta.

Discussion/Conclusion

We conclude that it is feasible to apply Waltz16 at 7T to achieve broadband ^{1}H-decoupling in-vivo in human muscle within the IEC guidelines, and this together with NOE enhancement will allow further extention of this technique for ^{13}C MRS measurements such as in human brain.

References

[1] M.J.Avison PNAS 1988. [2] A.J.Shaka et al, Magn Reson 1983. [3]W.Chen et al, Biochemistry 1993. [4] G. Adriany et al, Magn Reson 1997.

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