Double Quantum Spectroscopy Using Phase Rotation at 7T

S. Ramadan[1], E. M. Ratai[2], L. L. Wald[2], G. C. Wiggins[2], and C. E. Mountford[3]

[1]Department of Radiology, Brigham and Women's Hospital, Boston, MA, United States, [2]Department of Radiology, Massachusetts General Hospital, Boston, MA, United States, [3]Radiology, Brigham and Womens Hospital, Boston, MA, United States

INTRODUCTION

Phase-rotation is an alternative method to phase-cycling in acquisition of magnetic resonance spectroscopic data. Hennig [1] was the first to propose a new method to acquire localised spectroscopic data, where by various scans are stored as rows in a two-dimensional (2D) matrix, which is then doubly Fourier transformed (FT) and a specific row is extracted to represent the 1D spectrum. Phase-rotation was also implemented in a STEAM pulse sequence[2]. The aim of the present work is to implement the phase-roation technique on a high Bo whole body magnet.

MATERIALS AND METHODS

The technique was developed on apparently healthy volunteers with institutional review board approval. MR data was obtained using a 7T MR scanner (Siemens Medical Solutions, Erlangen, Germany), a 28 cm diameter de-tunable birdcage coil for excitation and a 8.5 cm diameter surface coil for signal reception. Localizer images were obtained using a gradient-echo imaging sequence. The voxel was placed in the tibial bone marrow. A double quantum filtered (DQF) sequence was written as described in literature [3]. The phase increments for 1st , 2nd and 3rd RF pulses where set to 22.5, 33.75, 15.0 degrees, respectively.

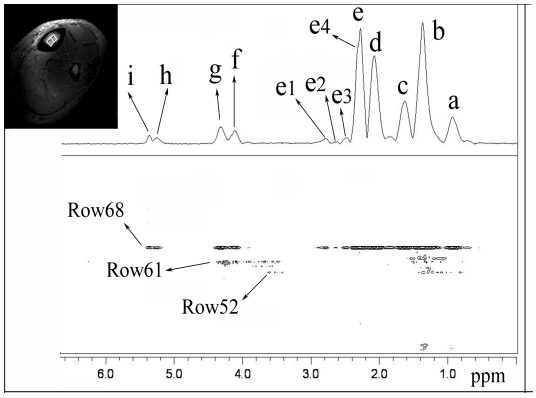
The spectral width was 4000 Hz, vector size 2048 points, voxel size of 6x6x35 mm^3, 1 averages and a repetition time of 2000 ms, 128 phase increments. The "WET" water suppression method[4] was applied before the acquisition sequence. The data was collected, concatenated, Fourier transformed (magnitude) and row 68 extracted. The processing was done with the MestReNova program[5]. The (C**H**2)n resonance at 1.30 ppm was used as a chemical shift reference[6].

RESULTS AND DISCUSSION

DQF signal (coherence transfer pathway: +1,+2,-1) was detected on row 68 (Figure 1). Two additional unwanted coherences where detected on row 61 (echo from 1st and 3rd rf pulses) and row 52 (fid from 2nd rf). In spite of using strong spoilers within the sequence, unwanted signal was detected on some rows, which might be an effect of the need of stronger spoilers at higher fields. Figure 1 also show the single quantum for comparison, and a striking difference is the ability of DQF signal to discriminate between the very similar chemical shifts (peaks i,h and g,f and others in Figure 1). Usually, a two-dimensional spectroscopic correlation experiment is needed for such discrimination. The underlying reason could be the elimination of all single quantum signal during DQF acquisition, allowing weak resonances to be discriminated.

CONCLUSION

DQF spectroscopy is feasible of a high field whole body magnet (7T), when acquired in phase rotation mode. Phase cycling based acquisition might suffer from incomplete cancellation of unwanted signal.



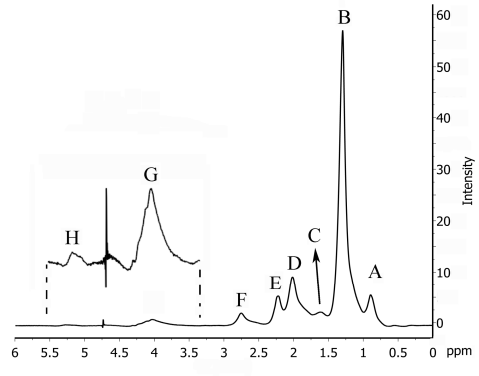


Figure 1. Axial image of voxel. (Left) 7T MRS 2D phase-rotation map with ^{1}H 1D DQF (row 68) spectrum of tibial bone-marrow (38 yo volunteer) shown on top. Note that the vertical axis represents "row number". (Right) PRESS-based 1D single quantum of the same voxel was also acquired for comparison.

Peak	Frequency (ppm)	Identity
a	0.86	C**H3**
b	1.30	(C**H2**)n
c	1.54	–O–(C=O)–CH2–C**H2**–
d	2.00	–C**H2**–CH=CH–
e	2.20	–CH**H**–(C=O)–OR
e1	2.24	–C**H**H–(C=O)–OR
e2	2.40	unassigned
e3	2.55	unassigned
e4	2.70	–CH=CH–C**H2**–CH=CH–
f	4.04	–(C=O)–O–C**H2**– (glyceryl c1 or c3)
g	4.24	–(C=O)–O–C**H2**– (glyceryl c3 or c1)
h	5.16	–(C=O)–O–C**H**R– (Glyceride)
i	5.28	–C**H**=C**H**–

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