A method for interleave measurements of ^{1}H, ^{1}H-{^{13}C}, and ^{31}P spectra from the same localized area at 4.7T wholebody system

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Introduction

Multinuclear MRS gives variety of information on the metabolic status in the localized region of human brain from different windows. However, techniques for obtaining multinuclear localized spectra in a measurement with single setting have not yet been exploited so far. Major difficulty to accomplish the multinuclear MRS was originated from the low sensitivity in the low gamma nuclei. On this point an increase in S/N at high field is beneficial. We reported a method for interleave measurements of ^{1}H and ^{31}P spectra from 3x3x3 cm^3 region in the human brain at 4.7T last year [1]. We extended the method to three nuclei of ^{1}H, ^{13}C, and ^{31}P by adding up a technique of editing the ^{1}H spectrum by ^{13}C to which ^{1}H is directly connected.

Methods

Three transmission and four reception channels were equipped with a 4.7 T Inova wholebody spectrometer (Varian, Palo Alto). We built a probe consisted from tree surface coils, two of which tuned for quadrature ^{31}P (8 cm in diameter), and one for ^{13}C (12 cm in diameter). The surface coil probe was successfully integrated with a ^{1}H TEM probe for head to allow triple nuclei measurements. The basic pulse sequence was a combined sequence of STEAM for ^{1}H and ISIS for ^{31}P used for the double nuclei measurement [1]. On the STEAM part we implemented an adiabatic ^{13}C 180 degree pulse during TM period for inverting *IzSz* state to edit ^{1}H spectrum [2]. A 25ms hyperbolic secant pulse gave effective inversion over 6kHz. TE for STEAM was adjusted to 7.7ms targeting the ^{1}H *sp3*-bonded to ^{13}C. Broadband decoupling of ^{13}C could be performed by applying ^{13}C MLEV pulses during data acquisition for ^{1}H [2]. Inversion of ^{13}C was performed in the alternate scan for ^{1}H, and the measurements of ^{1}H and ^{31}P were kept interleaved. Thus, ^{1}H, ^{31}P, ^{1}H (^{13}C inverted), and ^{31}P spectra were successively obtained in one cycle of the sequence. A twice measurement in ^{31}P was useful to compensate the low sensitivity in ^{31}P. We named the method as TRINITY (TRIple Nuclei Interleave in Trilple channel spectroscopY).

Results and Discussion

Performance of the TRINITY method was tested using a spherical phantom (4cm in diameter) containing 50mM acetate, 50mM glutamate, 100mM ATP, 100mM $MgCl_2$, and 5mM EDTA placed in 1L saline. Fig. 1 exhibits ^{1}H, ^{1}H-detected ^{13}C, and ^{31}P spectra obtained in an interleave manner from 2x2x2 cm^3 voxel with TR of 5s and 32/64 transients with ^{13}C decoupling. C-2 position on which ^{13}C was enriched to 98% was exclusively observed in the ^{1}H-{^{13}C} spectrum (Fig. 1b). Fig. 2 demonstrates the ^{1}H spectra with and without ^{13}C inversion obtained with a natural abundance sample without ^{13}C decoupling. In the difference spectrum (i.e. ^{1}H-ditected ^{13}C spectrum) the side band signals derived from natural abundance acetate C-2 were clearly observed with the center peak (^{1}H connected to ^{12}C) suppressed completely. The peak intensity of the side bands was 1.0% of the center peak obtained by adding (a) and (b), demonstrating a quantitative recovery of ^{13}C signal in the TRINITY measurement.

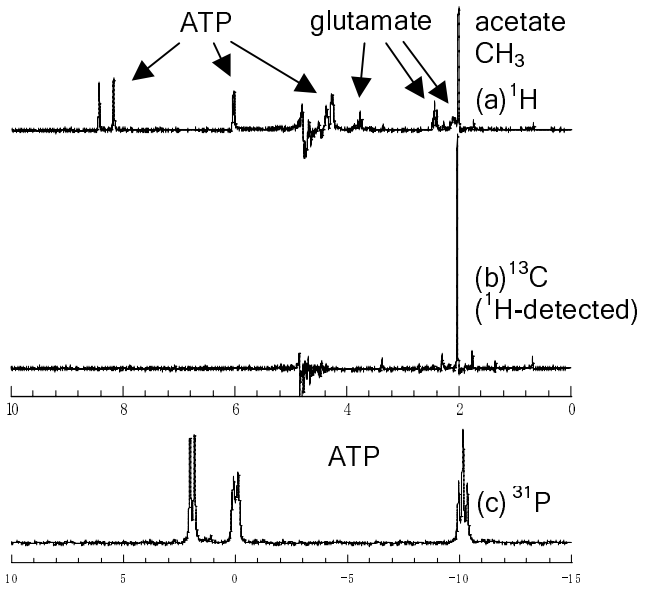

Fig.1. TRINITY spectra with ^{13}C decoupling obtained in a phantom containing 50mM 2-^{13}C acetate, 50mM glutamate, 100mM ATP, 100mM $MgCl_2$, and 5mM EDTA. (a) ^{1}H, (b) ^{13}C detected with ^{1}H, (c) ^{31}P. VOI=2x2x2cm^3, NT=32 (^{1}H), 64 (^{31}P), TR=5s, TE/TM=7.7/35ms for STEAM.

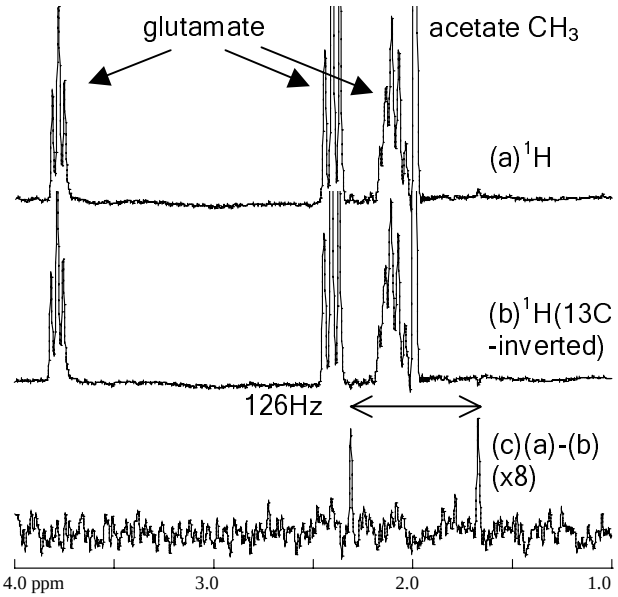

Fig.2. TRINITY spectra without ^{13}C decoupling obtained in a phantom containing natural abundance acetate, glutamate, and ATP. (a) ^{1}H, (b) ^{1}H with ^{13}C inverted, (c) (a)-(b). VOI=2x2x2cm^3, NT=512 (^{1}H), TR=5s, TE/TM=7.7/35ms for STEAM.

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References

[1] F.Mitsumori, N.Takaya, Proc.Int Soc.Magn.Reson.Med., 11, 1138 (2003).
[2]J.Pfeuffer, I.Tkac, I-Y.Choi, H.Merkle, K.Ugurbil, M.Garwood, R.Gruetter, Magn.Reson.Med., 41, 1077-1083 (1999).