SNAPSHOT: A rapid 13C MRS technique for clinical neurospectroscopy

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AIMS: Develop a robust practical procedure for the quantitative characterization of in vivo human brain ^{13}C metabolite profiles on a routine clinical MR scanner, in less than 30 minutes.

BACKGROUND: We recently demonstrated that in a variety of disease states, major differences in the patterns of metabolite enrichment evolve over time after 1-^{13}C glucose infusion. We therefore hypothesized that a single, rapid ^{13}C MRS acquisition ("SNAPSHOT") at the appropriate interval after enrichment outside the MR suite could contribute to neuro-diagnosis.

METHODS: MRI, ^{1}H and ^{13}C MRS were performed on a standard clinical MR scanner (GE LX 9.0; 1.5 Tesla), using the commercially provided, 'stand-alone' decoupler equipped with power monitor (GEMS, Waukeshau, WI).

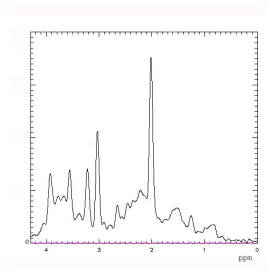
Human Subjects and ^{13}C enrichment protocols: All studies were performed with FDA (IND 56,510, 59,950) and IRB approval. Subjects were fasted for 6 hours before receiving pyrogen-free ^{13}C substrates (CIL, Andover, MASS) following protocols described in detail.

MRS protocol: SNAPSHOT employs two 'imaging' sessions, separated by an interval of 90 plus minutes. Session 1 (20 minutes): Landmarking, MRI, single voxel short TE MRS of posterior cingulate gyrus grey matter and non-localized decoupled ^{13}C MRS, 3 x 5 minute acquisitions, summed and stored. Enrichment interval (100 minutes): Patient preparation outside MR suite; blood glucose, I-V (or oral) ^{13}C substrate administered over 10 minutes; rest 90 minutes. Session 2 (20 minutes): repeat landmarking, MRI, ^{1}H and enriched ^{13}C MRS as Session 1. blood glucose, end.

Data Processing: mI/Cr in ^{1}H MRS was used to scale mI in natural abundance and enriched ^{13}C MRS. Relative to mI, ^{13}C metabolites were quantified after processing difference scaled difference spectra.

RESULTS: MRI demonstrates accurate re-positioning of the subject, whilst internal standard of mI is replicated in ^{1}H MR spectra.(fig 1) ^{13}C substrate, glucose (alpha and beta) as well as the end-products $H^{13}CO_{3\ (fig\ 2)}$ and ^{13}C enriched TCA cycle metabolites, glutamate (C2, C5), glutamine and aspartate are readily identified in the ^{13}C difference spectrum (fig 3).

Series I:



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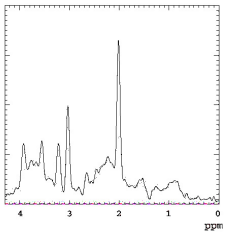

Fig 1 1HMRS

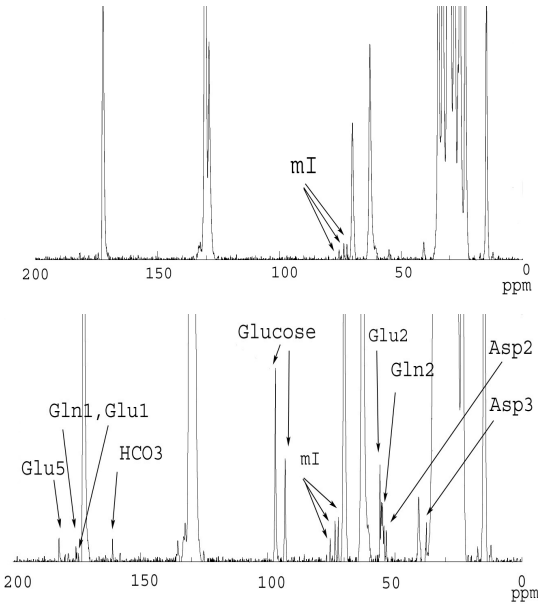

Fig2 13C MRS

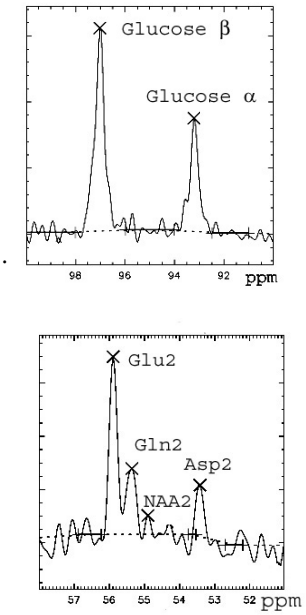

Fig 3 SNAPSHOT

DISCUSSION: In 10/10 consecutive subjects SNAPSHOT ^{13}C MRS was successful. All equipment used in this preliminary study is 'off the shelf'. This demonstrates the stability of clinical MR spectrometers and of commercially available DC. Using robust difference spectroscopy and automated data processing, SNAPSHOP can provide useful clinical results in a practical time frame.

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