3-D Enhanced Fast Gradient Echo ^{13}C Carbon Imaging in a 1.5T Clinical Scanner

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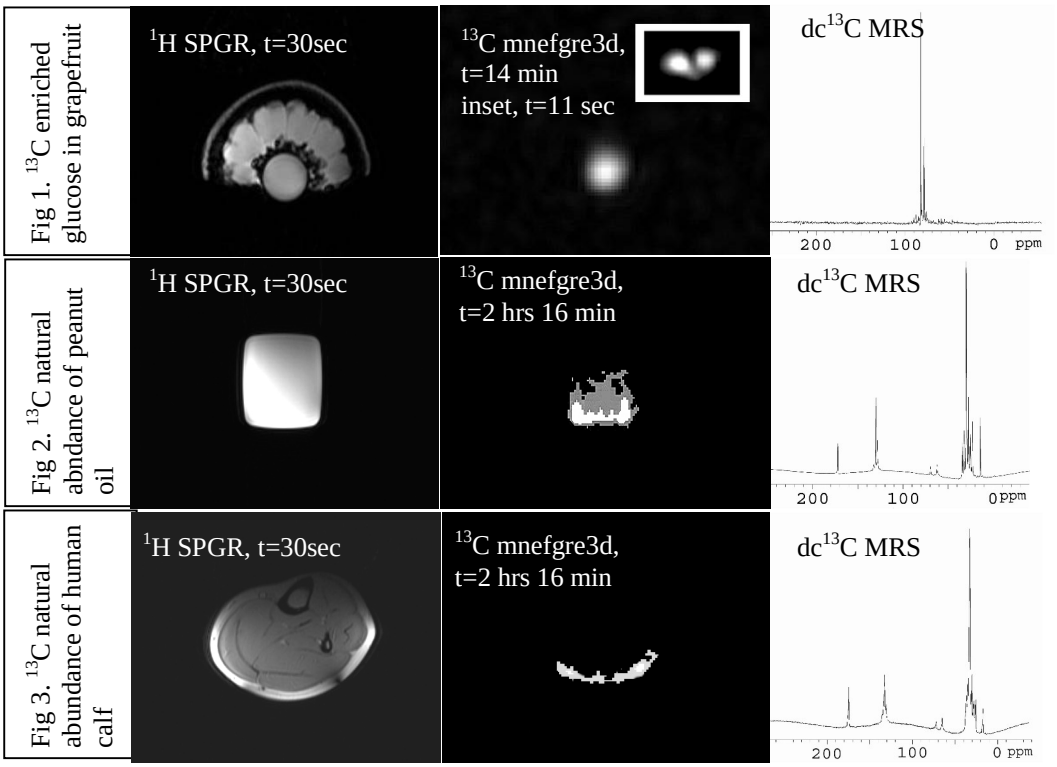
Background: ^{13}C natural abundance and post-enrichment by cell-specific ^{13}C precursor has found widespread efficacy in animal and human research[3] as well as clinical diagnosis[4-7]. PASADENA (Parahydrogen and Synthesis Allows Dramatically Enhanced Nuclear Alignment) has theoretical SNR advantage up to 10,000 times. We are exploring the diagnostic potential of ^{13}C PASADENA MRI and MRS[1,2]. We recently developed PASADENA using ^{1}H MRI detection[1,2], as no ^{13}C MRI sequence was available on our clinical 1.5T (GE LX) scanner. In this abstract we describe the development of a ^{13}C MRI sequence suitable for real-time ^{13}C PASADENA metabolite imaging *in vivo*.

Methods: EPIC source code (GE Healthcare, Waukesha, WI) of 3D enhanced fast gradient echo (efgre3d), successfully employed by one of us[8], was altered to allow capability for multi-nuclear image acquisition and reconstruction of 100% peanut oil, a grapefruit, and two ^{13}C glucose solutions (A=0.3 molar 1-^{13}C in 25 ml; B=7 molar 1-^{13}C in 50 ml). Biological confirmation was performed on *in vivo* human calf of normal volunteers. All studies were conducted in a GE 1.5T LX 9.1 MR scanner, using a custom ^{1}H-^{13}C head coil[3] and stand-alone proton decoupler (GE, Fremont, CA)[5].



Results:
The sequence was tested *in vitro* (Fig 1) using ^{1}H MRI (left), ^{13}C MRI (middle), and ^{13}C MRS (right). Natural abundance (1%) of peanut oil (Fig 2) and of human calf lipid (Fig 3), determined by ^{13}C MRS to 64 mmols of ^{13}C, achieved excellent ^{13}C images in longer exam times. Assuming *in vivo* PASADENA theoretical signal enhancements of 20,000 (PB, DPW, BDR unpublished) or 1000 (experimental observation by PB, DPW, BDR unpublished), together with the known fractional enrichment of target intracerebral metabolites[6] between 5-20% for ^{13}C, and the SNR observed here in ^{13}C phantoms and *in vivo* we can perform comparable or higher resolved PASADENA metabolite MRI in less than 5 seconds.

Conclusion: The current sensitivity of a clinical 1.5T scanner is sufficient to perform *in vivo* ^{13}C PASADENA imaging and spectroscopy during the anticipated physiological brain delivery of hyperpolarized ^{13}C reagents.

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