1H-MR Spectroscopy Utilizing a 1T Open MR System: Expanding Access to the Obese and Claustrophobic Patient Populations

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Introduction: Proton MR Spectroscopy (^{1}H-MRS) has been established for many years as a valuable tool in the study and diagnosis of neurological disorders, and useful for oncological follow-up of post treatment brain tumors. Routine use of ^{1}H-MRS has been restricted to cylindrical geometry high field MR systems, excluding both the non-sedated claustrophobic and growing obese patient populations. While a few studies have investigated the clinical use of ^{1}H-MRS below 1.5T[1-3], virtually all spectroscopy studies today are performed at or above 1.5T. The purpose of this study was to explore the clinical utility of ^{1}H-MRS on a commercially available high field (1.0T) open MR system, and compare the signal-to-noise ratio (SNR) and spectral quality of the 1.0T spectra with data collected at 1.5T and 3.0T.

Methods: Water-suppressed single voxel ^{1}H-MRS (SVS) of the brain was performed with Point Resolved Spectroscopy (PRESS) localization on a clinical Panorama 1.0T open whole-body MR system (Philips Medical Systems, Best, The Netherlands), a clinical Intera NT 1.5 MR system (Philip Medical Systems. Best, The Netherlands), and a clinical Achieva 3.0T MR system (Philips Medical Systems, Best, The Netherlands). A four-channel Solenoid Technology (ST) SENSE head coil was used for MRI and MRS of the brain at 1.0T. In order to compare the SNR, a six-channel SENSE head coil was used for MRI and MRS of the brain at 1.5T and 3.0T. Using a TR/TE of 2000/144 ms, eight patients (mean age 58 $\pm$ 18 yrs) were examined for the spectral quality of their N-acetyl aspartate (NAA), creatine (Cr), and choline (Cho) resonances, the signature metabolites at this echo time. Data were analyzed for SNR and peak resolution for all three field strengths for one of the patients, while another patient was examined using a short TE SVS (2000/29 ms) to observe short T2 chemical species. SVS was acquired with an 8 cc voxel, 128 signal averages, and sampling bandwidths of 500 Hz (1.0T), 1 kHz (1.0T, 1.5T) and 2 kHz (3.0T). MRS scan times were 4min and 55sec.

Results: Figure 1 shows a typical SVS ^{1}H-spectrum with a TE of 144 ms acquired on a 43 yr patient with normal brain chemistry. The Cho/Cr peaks at 3.2 and 3.0 ppm were clearly resolved in all patients, with the spectra from all of the patients exhibiting good SNR. The Cho/Cr and NAA/Cr peak area ratios for all patients were found to be 1.1 +/- 0.2, and 2.3 +/- 0.4, respectively. Figure 2 shows the SVS ^{1}H-spectrum with a TE of 29 ms acquired on a 26 yr patient, clearly showing resolved metabolite resonances not seen in the longer TE spectra, including myo-inositol (mI) at 3.56 ppm and the Glx -CH- triplet at ~3.8 ppm. The J-coupled Glx peak at ~2.25 ppm is more coalesced and hence more conspicuous at 1.0T than at 1.5T, as was observed previously at 0.5T[3]. Table 1 summarizes the SNR measurements of the ^{1}H-MRS of a 50 yr patient obtained at 1.0T, 1.5T, and 3.0T. The observed SNR of the 1.0T open system is remarkably good relative to 1.5T and 3.0T. The less than linear dependence of SNR with field strength reflects the use of non-identical head coil geometries (ST at 1.0T, six channel array at 1.5T and 3.0T).

Discussion: Although the trend towards higher field strengths for increased SNR and spectral dispersion continues, this study demonstrates that high quality ^{1}H-MRS that is clinically useful can be performed with a high field open magnet configuration. With the growing number of habitus-limited radiology studies due to the increasing numbers of obese patients[4], the use of high field open MR systems to diagnose obesity related disease processes such as Type 2 diabetes will become increasingly important. Further refinements of the 1.0T open MRS acquisition techniques hold promise for increasing the SNR and spectral quality, as well as expanding into multi voxel spectroscopic techniques. Other anatomical areas such as prostate and breast are under investigation, with the appropriate adjustments in data acquisition techniques for 1.0T.

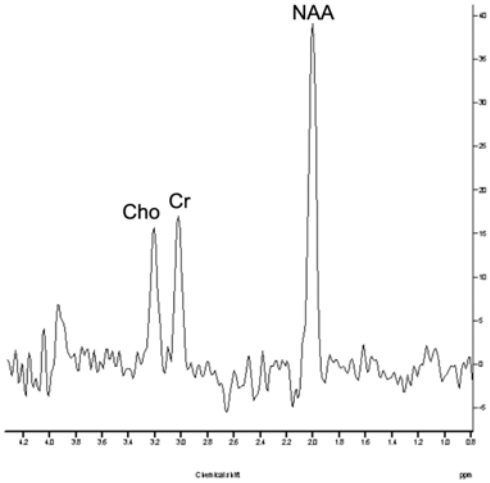

Fig. 1: Patient with normal brain tissue, single-voxel spectrum from an 8 cc volume, TR/TE 2000/144 ms, 1 kHz bandwidth

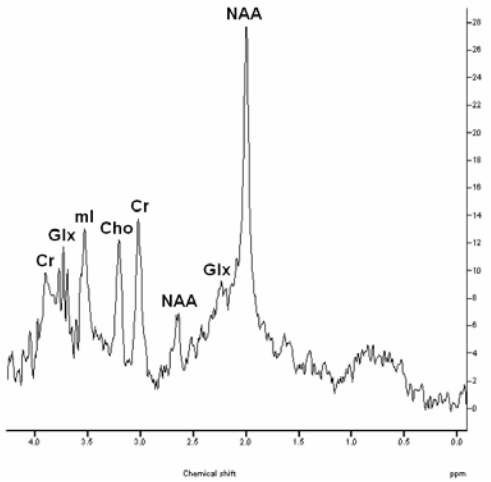

Fig. 2: Patient with normal brain tissue, single voxel spectrum from an 8 cc volume, TR/TE 2000/29 ms, 500 Hz bandwidth. Note the resolved Glx –CH- triplet at ~3.8 ppm

Table 1: SNR ratios for NAA, Cr, and Cho measured on a single patient at 1T, 1.5T, and 3T for a single-voxel spectrum from an 8cc volume, TR/TE 2000/144 ms.

Field Strength Ratio	SNR_{Cho} Ratio	SNR_{Cr} Ratio	SNR_{NAA} Ratio	SNR_{Ave} Ratio
1.5T:1.0T	1.2	1.3	1.4	1.3
3.0T:1.0T	1.7	2.1	2.2	2.0
3.0T:1.5T	1.4	1.7	1.5	1.5

References

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