Comparison of glutathione (GSH) concentrations quantified with STEAM versus edited spectroscopy: application to schizophrenia.

M. Terpstra[1], S. C. Schulz[2], J. T. Vaughan[1], K. Ugurbil[1], K. O. Lim[2], R. Gruetter[1]

[1]Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, MN, United States, [2]Psychiatry, University of Minnesota, Minneapolis, MN, United States

Introduction

GSH is a powerful antioxidant that is altered in many diseases, potentially including schizophrenia (1). GSH is challenging to quantify from short-echo-time ^{1}H NMR spectra (2), since none of the glutathione (GSH) resonances are well resolved at 4T in vivo (fig. 1). Fortunately, GSH has been resolved in vivo using editing (1, 3, 4). Therefore, this study was designed to compare the GSH concentrations measured using STEAM versus edited spectroscopy in a clinically relevant volume of interest. In addition, since other metabolites such as glutamine (Gln) may be important in schizophrenia (5), neurochemical profiles were measured.

Methods

All studies were conducted with a 4T/90 cm (Oxford/ Varian) system and a TEM volume coil. Multislice RARE imaging was used for selection of a volume of interest (VOI) in the most anterior portion of the cingulate cortex. Shimming was optimized with FAST(EST)MAP (6). STEAM spectra (TE=5 ms, TR=4.5 s, TM=42 ms) were acquired and analyzed using LCModel resulting in a neurochemical profile (2). The repeatability of the neurochemical profile was tested in a 2x2x2 cm^3 VOI (NEX=256) in 23 volunteers. MEGA-PRESS editing for GSH (3) was performed in a slightly larger VOI (23x22x33 cm^3, NEX=512) in five volunteers, and the metabolite profile was re-measured using STEAM (NEX=64) in the larger VOI.

Results and Discussion

The GSH concentration measured using STEAM in the 17 ml VOI was 1.5 ± 0.1 (m ± SD, n=5), and that using editing was 1.3 ± 0.2 (m ± SD, n=5). The two methods agreed within experimental error ($p>0.05$). The excellent agreement between GSH concentrations measured by editing and STEAM suggests that GSH was accurately measured in short-echo spectra. CRLB and SD in the neurochemical profiles measured using STEAM in the 8 ml VOI (table 1) were comparable to previous studies of schizophrenia (5). We conclude that reliable quantification of GSH is possible using volume coils and short echo time spectroscopy at high fields from small, clinically relevant VOIs in patients, provided spectral resolution is adequate.

Table 1: Metabolite concentrations (mM) quantified in 23 controls (8 ml VOI) and average Cramer-Rao Lower Bound (CRLB), which is an estimate of the SD of each individual measurement.

Metabolite	mean	SD	CRLB
Gln	3.23	0.47	11%
Glu	10.55	0.60	4%
GSH	1.56	0.16	12%
NAA(G)	10.13	0.67	3%
(P)Cr	9.06	0.41	3%

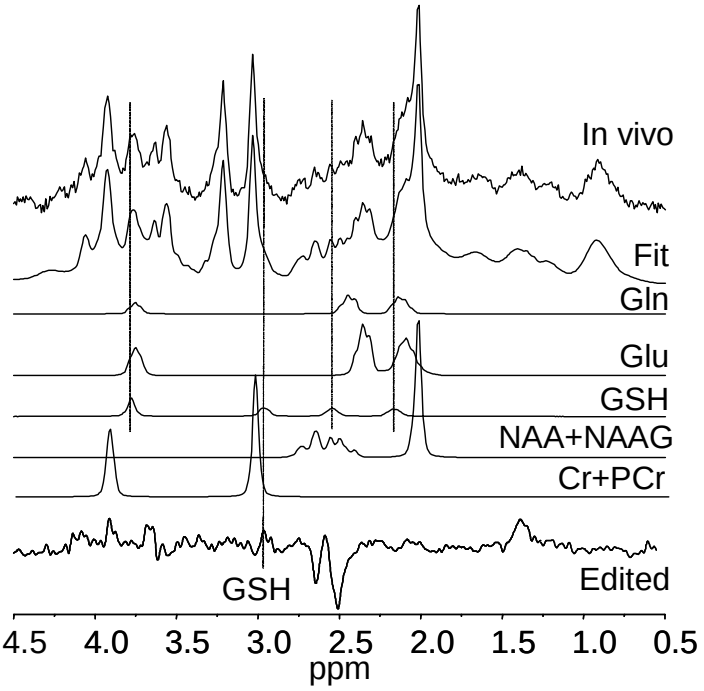

Fig. 1: STEAM spectrum (8 ml VOI), LCModel fit and metabolites, and edited in vivo spectrum (15 ml VOI).

References and Acknowledgments

1) Do et al. Eur J Neurosci 12:3721, 2000. 2) Pfeuffer et al. J Magn Reson 141:104, 1999. 3) Terpstra et al. Magn Reson Med 50:19, 2003. 4) Choi et al. ISMRM Toronto: 522, 2003. 5) Theberge et al. Am J Psychiatry 159:1944, 2002. 6) Gruetter et al. Magn Reson Med 43:319. 2000.

MIND institute, NIH:P41RR08079.