Measurement of the Effects of Different Anesthetics in the Rat Thalamus by *in vivo* ^{1}H NMR Spectroscopy at 16.4T

S-T. Hong[1], C-B. Choi[2], and R. Pohmann[1]
[1]High-Field Magnetic Resonance Center, Max-Planck Institute for Biological Cybernetics, Tuebingen, Baden-Wuerttemberg, Germany, [2]Department of Radiology, Kyung Hee University Medical Center, Hoekidong, Seoul, Korea, Republic of

Introduction

Localized *in vivo* ^{1}H NMR spectroscopy in the rat brain has demonstrated alterations in the concentrations of metabolites, mainly glucose, under various anesthetic agents. A high dose of pentobarbital showed significantly decreased glucose in the rat brain compared with rats under isoflurane anesthesia [1]. Similarly, a substantial increase of glucose was reported in rat cortex under deep thiopental anesthesia compared to rats under light α-chloralose [2]. In this study, we investigated differences of the neurochemical profile caused by anesthesia under two of the most used anesthetics, isoflurane and ketamine/xylazine, in the thalamus of the rat brain at 16.4T.

Methods

Ten Sprague-Dawley rats were separated into two groups, isoflurane (n = 5) and ketamine (100 mg/kg)/xylazine (10 mg/kg) (n = 5). Ketamine/xylazine was administrated intramuscularly without inducing anesthesia with isoflurane to investigate the uncontaminated anesthetic effect. All experiments were performed on a horizontal 16.4 T/26 cm magnet (Magnex Scientific, Abingdon UK) interfaced to a Bruker spectrometer (Bruker BioSpin GmbH, Ettlingen, Germany), using a 14 mm diameter quadrature surface coil as a transceiver. Water suppression was performed using seven water suppression pulses (VAPOR) interleaved with three modules of outer volume saturation (OVS) before a localization scheme [3]. An ultra-short TE STEAM sequence, TR 5000 ms, TE 1.7 ms, TM 20 ms, 256 averages and 2048 complex data points, was applied to obtain spectra from a rectangular volume-of-interest (VOI) in the thalamus (6.5 x 3.5 x 2.5 mm^3). During measurements, body temperature was maintained at 37 ± 0.5 ^{0}C by an electric heating pad and monitored through a rectal temperature sensor. All spectra were quantified using LCModel [4] with the basis set composed of numerically calculated metabolite spectra and simulated MM components. Statistical analysis was done with the SPSS software package (SPSS 15.0 for Windows, SPSS Inc., Chicago, IL USA). Multivariate Analysis of Variance (MANOVA) was employed to compare metabolite concentrations between the two groups.

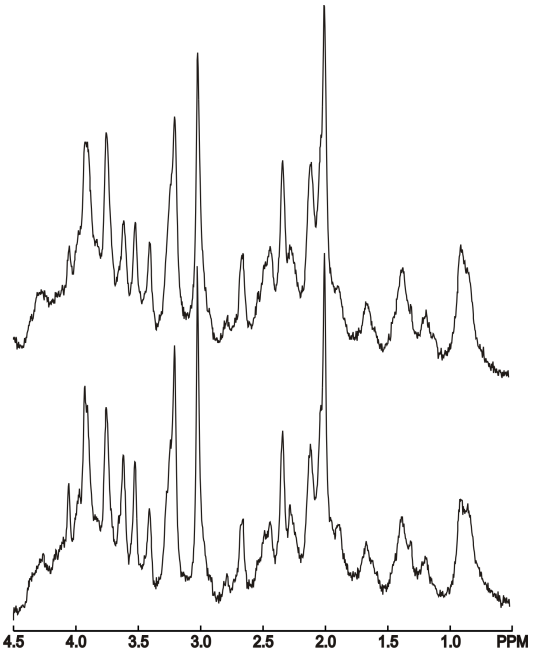

Figure 1. Localized *in vivo* proton MR spectra in thalamus under isoflurane (bottom row) and under ketamine/xylazine (upper row). Eddy current correcton, Fourier-transform and phase correction were applied. Both spectra were scaled consistently.

Results and Discussion

Fig. 1 shows representative *in vivo* ^{1}H MR spectra obtained in the thalamus of the rat brain. The high sensitivity at 16.4T allowed observation of specific metabolite alterations caused by different anesthesia agents (Fig. 2). The altered level of glucose in deep ketamine/xyzaline anesthesia is well agreement with previous results [1, 2], implying the variation of brain energy metabolism. However, additional metabolite variations suggested involvements of antioxidants and neurotransmission under anesthesia with different anesthetic agents. Further studies on additional brain regions would be required for a more complete insight into the mechanism of various anesthetic agents.

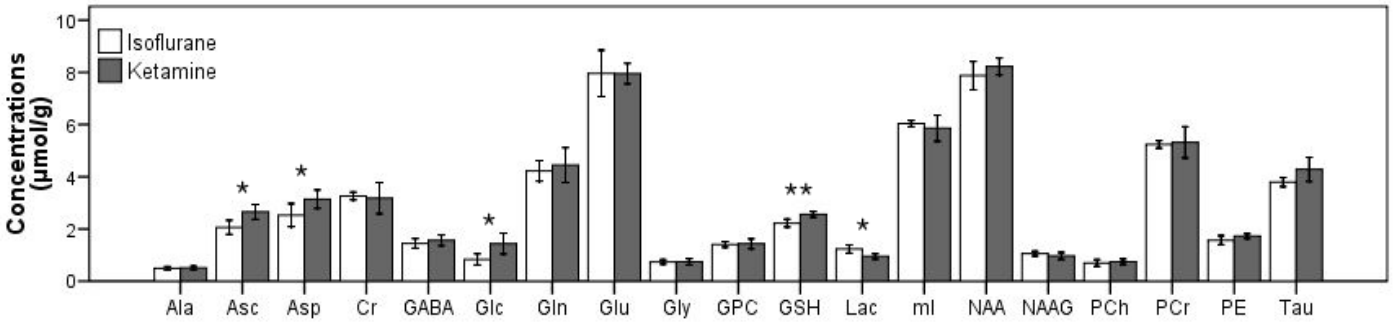

Figure 2. Metabolite concentrations in thalamus of the rat brain with different anesthesia, isoflurane (white) and ketamine/xylazine (gray). Error bars indicate standard deviations. The asterisk represents different statistical significance, *P < 0.05 and **P < 0.005.

References

[1] Du F et al., MRM 2009;In press. [2] Lei H et al., J Neuroscience Research 2009;In press. [3] Tkac I et al., MRM 1999;41:649-656. [4] Provencher SW. MRM 1993;30:672-679.