Effects of Binge Acute Ethanol Intoxication on Cerebral Neurochemical Profile in Rats: Evidence from In Vivo Proton Magnetic Resonance Spectroscopy

Do-Wan Lee1, Jae-Hwa Kim2, Sang-Young Kim3, Dai-Jin Kim3, Jinyoung Jung1, and Bo-Young Choe1
1Department of Biomedical Engineering, The Catholic University of Korea, College of Medicine, Seoul, Seoul, Korea, 2Department of Biomedical Science, The Catholic University of Korea, College of Medicine, Seoul, Seoul, Korea, 3Department of Psychiatry, Seoul St. Mary’s Hospital, The Catholic University of Korea, College of Medicine, Seoul, Seoul, Korea

Introduction:
Binge alcohol consumption (heavy consumption of alcohol over a short period) is associated with various adverse consequences, including increased risk of developing alcohol dependence [1]. In particular, binge alcohol intoxication causes cerebral metabolite alterations and impairments [2]. In this study, the cerebral metabolite changes in vivo were quantitatively assessed in binge ethanol-intoxicated rats by using a 4.7-T proton magnetic resonance spectroscopy (1H MRS).

Results:
In this study, thirteen 8-week-old, male Sprague–Dawley rats were used and divided into 2 groups (control group: n = 6; binge ethanol group: n = 7). The 7 binge ethanol group rats received an initial dose of 5 g/kg (30% w/v solution) via oral gavage method, followed by a maximum dose of 2 g/kg (25% w/v solution) every 8 h (at 1400, 2200, and 0600) for 4 days. The 6 control group rats simultaneously received equal volumes (about 3.55 ml) of normal saline (at 1500, 2300, and 0700).

Materials and Methods:
Four days after oral gavage, in vivo scanning was performed on all the animals using a 4.7-T Bruker BIOSPEC. The volume of interest (VOI, 6 × 2 × 3 mm3; volume: 36 μL; Fig. 1 [A and B]) was positioned in the hippocampus based on multi-slice T2-weighted images obtained using Rapid Acquisition with Relaxation Enhancement (RARE) sequences (TR/TE = 5000/90 ms; number of acquisitions = 4; slice thickness = 1.0 mm). Thirteen water suppressed 1H MRS spectra were acquired using Point-Resolved Spectroscopy (PRESS) sequences (TR/TE = 4000/20 ms; number of acquisitions = 384; number of data points = 2048). In addition, the unsuppressed water signal was acquired (TR/TE = 4000/20 ms; and number of acquisitions = 16). All spectra were analyzed using LCModel with simulated basis-set.

Discussion:
This study aimed to quantitatively assess the cerebral neurochemical effects in the hippocampal region in binge ethanol intoxicated rats. Significantly reduced choline-containing signals could be observed in alcohol-dependent patients [4]. Seitz et al., reported that the choline/creatine (Cho/Cr) ratios were significantly decreased in alcohol-dependent patients than that in healthy subjects. Chang et al., reported also that the choline-containing compound is a marker of cell membrane turnover (from synthesis and degradation) [5]. Moreover, previous studies have shown that reduced choline-containing signals may reflect altered cell turnover rate of phosphatidylcholine and other phospholipids reflecting an adaptive mechanism of the brain [6,7].