Positive correlation of glycerophosphocholine with alcohol consumption in frontal white matter of light social drinkers revealed by 3D ^{31}P MRSI using RINEPT editing

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Introduction

It has been previously shown that the ^{1}H MRS signal of choline containing compounds (Cho) is below-normal in alcohol dependent patients after detoxification and increases with duration of abstinence [1-3]. In a study of light social drinkers a significant positive correlation of alcohol consumption during the last 90 days with Cho in frontal WM and in the anterior cingulate gyrus has been found [4]. Besides the implication that monitoring for alcohol consumption (and potentially nicotine and other drugs) is mandatory in MRS studies, it is yet unclear which choline compound(s) contribute to the correlation of Cho with alcohol consumption. Phosphorous MRS can provide more specific results in this respect since the choline containing compounds can be separated by their chemical shift. In our study we utilized 3D ^{31}P MRSI including the RINEPT editing procedure [5] to resolve and quantify phosphoethanolamine (PE), phosphocholine (PC), glycerophosphoethanolamine (GPE) and glycero-phosphocholine (GPC) metabolites in the brain of light social drinkers.

Methods

3D ^{31}P MRSI data of 13 healthy subjects (8 men and 5 women, 26 to 51 years, mean age of 39, SD 7 years) were acquired. The participants were mild social drinkers with a mean of 1.0 drinks per day (minimum 0.0 drinks, maximum 3.2 drinks, SD 0.9 drinks per day over the last three months) where a drink is defined by 12 g alcohol. All measurements were performed on a 1.5 T Siemens Vision system with a double resonant ^{31}P-^{1}H volume head coil (RAPID Biomedical, Wuerzburg, Germany). For localization, 2D FLASH images in sagittal and transverse orientation were acquired. The measurement parameters for the 3D RINEPT MRSI included TR = 0.5 s, $TE_{1/2}$ = 40 / 32 ms and FOV = 400 mm. 3D spatial localization (8 x 8 x 8 encoding) is obtained by phase encoding gradient pulses which are free from chemical shift displacement errors. Spherical encoding reduces scan times by 45% [5]. In all MRSI measurements proton decoupling during acquisition was employed using a WALTZ-4 pulse train on a second independent transmit channel. The MRSI data were fitted in the time domain with jMRUI using the AMARES algorithm [6]. Voxel selection was done using home developed software and SID from SITools [7]. The metabolite values are expressed as ratios with the total phosphorous RINEPT signal intensity (totalP).

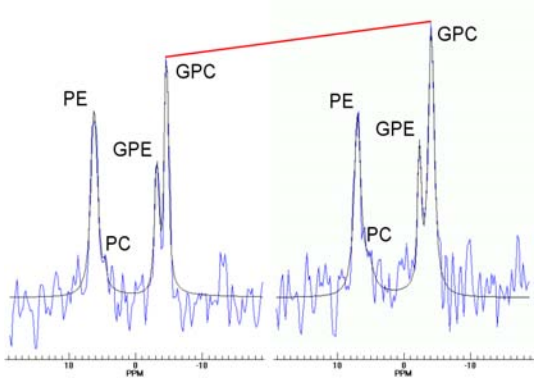

Figure 1: Comparison of two 3D RINEPT edited spectra from left frontal white matter for different alcohol consumption (left: female, 0 drinks per day; right: male, 3.2 drinks per day; measuring time 37 minutes, spatial zero filling to 16 x 16 x 16, spatial Hamming filter, voxel volume 15.6 ml interpolated).

Results

The 3D ^{31}P RINEPT MSRI sequence provides high quality spectra of PE, PC, GPE and GPC metabolites in the human brain. Figure 1 shows two exemplary spectra from frontal white matter (WM). We found a significant positive correlation of alcohol consumption during the last 90 days with frontal WM GPC/totalP which is shown in Figure 2. Since there was no significant hemisphere difference the average of left and right hemisphere values are plotted. No significant correlation neither in any other region nor of alcohol consumption with PE/totalP, GPE/totalP or PC/totalP were found. Our results are in agreement with previous Cho spectroscopic findings in light social drinkers by Ende et al. [4] and with an initial Cho increase in chronically alcohol exposed rats that is followed by a significant Cho decrease with increasing duration of alcohol exposure by Lee et al. [8]. The authors of the latter interpret their findings with an initially increased turnover of PC and other phospholipids. In contrast to their interpretation we did not find any significant change of the PC/totalP values with alcohol consumption. However, this might be due to insufficient S/N for this metabolite in the RINEPT spectra.

Our data do not support significant gender differences in the correlation of GPC/totalP with alcohol comsumption. The evidently huge difference of frontal WM GPC/totalP values between our one female who doesn't drink alcohol at all (because of religous reasons) and subjects with very little alcohol consumption might be a hint for a non-linear correlation of GPC/totalP with alcohol (Figure 2). A larger number of subjects will have to be examined to clarify this point.

In conclusion, the repeated finding of a positive correlation of alcohol consumption and frontal choline measures, and more specifically of the frontal white matter GPC/totalP signal, suggest that already small amounts of alcohol have an impact on brain metabolism and reflect adaptive mechanisms to alcohol consumption.

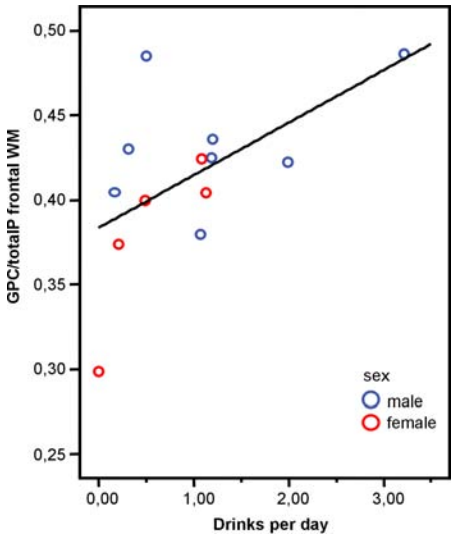

Figure 2: Frontal white matter GPC/totalP ratio as a function of alcoholic drinks per day. R = 0.565 (p = 0.44).

References

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