Hemispherical asymmetry contributes to preserved language abilities in alcohol dependents: A combined 1H MRS and VBM approach

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Target audience: Researchers working in the field of drug abuse and Neuroimaging.

Purpose: Chronic alcoholism is known to impair performance in a variety of cognitive functions. Numerous neuropsychological studies have shown that alcohol dependence is associated with neurocognitive deficits in tasks requiring memory, perceptual motor skills, abstraction and problem solving, whereas language skills are relatively spared in alcoholics.[1] The language functions are primarily left lateralized as per literature citation.[2] A recent fMRI study at our centre has also shown the involvement of left parietal and temporal lobes in maintaining the unscathed language skills.[3] Taking this into consideration, we aimed at exploring the metabolic and structural correlates of preserved language abilities. To that end, we performed a ^{1}H MRS study on parietal and temporal lobes bilaterally along with a whole-brain, voxel-based morphometry (VBM) analysis using DARTEL (Diffeomorphic Anatomic Registration Through Exponentiated Lie algebra algorithm) to look for metabolic alterations and morphometric changes, if any, respectively.

Material and methods: High resolution structural MR images were taken in 20 alcohol dependent subjects (n=25) and 20 healthy non alcoholic controls (n=20) matched for age, sex and education. The ^{1}H MRS voxel was positioned in superior parietal lobule and middle temporal gyrus bilaterally. Proton MRS data was acquired using single voxel (SVS) point resolved spectroscopy sequence (PRESS) (Parameters: TR=3300ms, TE= 30ms, voxel size=12*12*12 mm, averages=256, Number of spectral points=2048) with water suppression. LC model was used for data processing. Relative concentrations of N-acetylaspartate (NAA), choline-containing compounds (Cho), myo-inositol (mI) and combined glutamate-glutamine (Glx) were measured. The results were reported as ratios relative to creatine at p values (≤0.05). The VBM analysis was carried out using SPM8 software on MATLAB 7.6.0 platform. The whole study was carried out using 3T whole body MR system (Magnetom Skyra, Siemens, Germany) with a 32 channel head coil.

Results and discussion: VBM results showed a significant reduction in both gray and white matter volumes in alcohol dependents as compared to controls. Gray matter volume loss was observed bilaterally in fronto-parietal brain regions namely, frontal gyrus, postcentral gyrus and superior parietal lobule whereas significant white matter volume loss was observed primarily in right hemisphere regions namely, inferior parietal lobule, frontal gyrus and temporal gyrus. No areas of white matter loss were observed in left hemisphere. Even the gray matter volume loss was more prominent in right hemisphere as compared to left suggesting the preservance of cognitive functions associated with left hemisphere (Fig.1). As language abilities are primarily ascribed to left lobe, the intact white matter and gray matter volumes in left hemisphere correlates well with the preserved language abilities in alcohol dependents. Proton MRS results in right parietal and temporal lobes showed alcohol-associated significant reductions in NAA/Cr and Glx/Cr ratios whereas there was a significant increase in Cho/Cr and mI/Cr ratios (p value ≤0.05). The metabolite ratios followed a similar trend in left parietal and temporal lobes but it did not reach the level of statistical significance except for mI/Cr ratio (See table for details). Reductions in NAA levels might be attributed to neuronal loss while reductions in Glx levels might reflect perturbation of Glu-Gln system in alcohol dependents which could represent a neuroprotective adaptation. Raised mI may reflect astrocyte proliferation as well as an osmotic response to cell shrinkage whereas a significant increase in Cho levels indicate altered cell membrane metabolism. The preserved metabolite ratios in left hemisphere again suggest preserved verbal functions.

Conclusion: The present study leads us to conclude that comparatively preserved metabolite ratios and intact gray and white matter volumes in left hemisphere as compared to right hemisphere contributes to preserved language abilities observed in alcohol dependent subjects.

References

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2. Ellis RJ, Oscar-Berman M. Alcoholism, aging, and functional cerebral asymmetries. Psycholog Bulletin 1989; 106:128–147.
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Metabolite ratios	Left Parietal lobe		Right parietal lobe	
	Alcoholics	Controls	Alcoholics	Controls
NAA/Cr	1.488±0.38	1.561±0.11	1.264±0.31	1.540±0.21*
mI/Cr	0.924±0.21	0.873±0.19*	0.942±0.13	0.892±0.17
Glx/Cr	1.395±0.13	1.473±0.13	0.971±0.14	1.421±0.02*
Cho/Cr	0.236±0.06	0.217±0.04	0.280±0.02	0.228±0.06*

Metabolite ratios	Left temporal lobe		Right temporal lobe	
	Alcoholics	Controls	Alcoholics	controls
NAA/Cr	1.548±0.41	1.573±0.22	1.294±0.28	1.552±0.17*
mI/Cr	1.078±0.14	0.762±0.01*	1.131±0.41	0.727±0.03*
Glx/Cr	1.161±0.21	1.197±0.16	0.993±0.13	1.178±0.11
Cho/Cr	0.204±0.01	0.198±0.03	0.248±0.01	0.191±0.01*

Table: Results of in vivo MRS studies on parietal and temporal lobe in alcoholics and controls (*p value≤0.05).

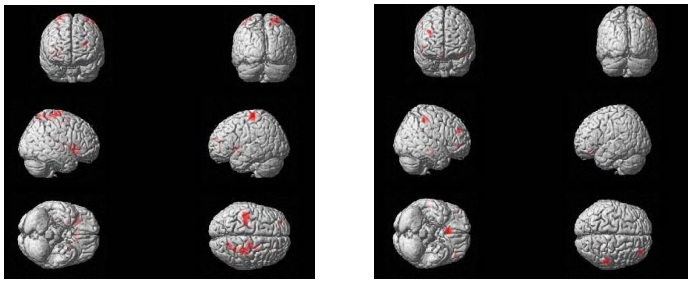

Fig.1. 3D rendered view of, (a) gray ,(b) white matter loss in alcoholic>controls.