Proton MR spectroscopic characterization of Alzheimer's disease, fronto-temporal type of dementia and progressive supranuclear palsy by a 3.0 Tesla system

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Introduction: In vivo proton (^{1}H)-MRS has been used to evaluate brain metabolites, such as N-acetylasparatate (NAA), Chreatine+phosphocreatine (Cr), Choline-containing compounds (Cho), and *myo*-Inositol (mI). These metabolites concentration have been considered to reflect neuropathological processes in the disease brain. Foregoing studies using ^{1}H-MRS reported NAA decrement and mI increment in the occipital or the temporal lobes of patients with Alzheimer's disease (AD) and in the frontal lobes of patients with fronto-temporal type of dementia (FTD). However, these studies were conducted by using 1.5Tesla MR systems.[1,2] By using 3.0Tesla MR system, we tried to demonstrate disease specific metabolites changes in the brain of patients with degenerative diseases including AD, FTD or progressive supranuclear palsy (PSP).

Material and method: We recruited seven patients with AD (5 men and 2 women; mean (±SD) was 70.0±10.7 years old), five patients with FTD (4 men and 1 women; mean (±SD) was 64.9±7.0 years old), three patients with PSP (3 men and 0 women; mean (±SD) was 70.0±3.0 years old) and 14 healthy volunteers (5 men and 9 women; mean (±SD) was 60.7±8.7 years old). All patients with AD met NINDS-ADRDA criteria for probable AD and all patients with FTD met diagnostic criteria of Lund and Manchester criteria and all patients with PSP met NINCDS □SPSP diagnostic criteria. MRI and ^{1}H-MRS were performed on a whole body 3.0 Tesla system (Sigma VH/i, GE Medical Systems, Milwaukee, WI, US) using a standard quadrature head coil. After obtaining 3D T1-weighted anatomical images, localized single voxel ^{1}H-MRS data were acquired using PRESS sequence with TR/TE=6000ms/25ms. Four 8cm^3 (2cm x 2cm x 2cm) volumes of interest (VOI) were located. The VOI in the posterior cingulate (PC) gyrus was placed in the mainly including the posterior cingulated gyrus. The VOI in the parieto-occipital lobe (PO) was placed in the region adjacent to the posterior horn of the left lateral ventricle. The VOI in the anterior cingulate (AC) gyrus was placed in the region including the anterior cingulated gyrus. The VOI in the frontal lobe (Fr) was placed adjacent to the anterior horn of the left lateral ventricle. (**Fig**) MRS data evaluation was performed with LC Model software,[3] and metabolites ratio using Cr as internal standard ware calculated for NAA, Cho and mI. Statistical analyses were performed using one-way ANOVA followed by post hoc analysis of Bonferroni's, and $p<0.05$ was considered to be significant.

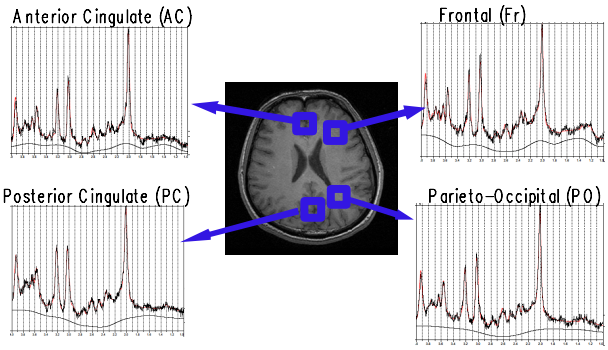

Figure: Representative location of four VOIs and acquired data from each VOI.

Result: There was no significant difference in age among each group. Metabolites ratio of each VOI was shown in the **Table**. In the AD group, NAA/Cr ratios were decreased in the posterior cingulated gyrus compared to the normal group. In the FTD group, NAA/Cr ratios decreased in the anterior cingulated gyrus, the frontal lobe and the posterior cingulated gyrus compared to the normal group. In the anterior cingulated gyrus and the frontal lobe, mI/Cr ratios increased compared to two other dementia groups, and these ratios also increased to the normal group in all four regions. In the PSP group, even not statistically significant, NAA/Cr ratios decreased compared to the normal group ($p=0.18$), but mI/Cr ratios showed decreased to the normal group.

Conclusion: Our result of investigation using a 3.0 Tesla MR system was almost consistent with those using 1.5 Tesla systems. However, increment of mI/Cr ratios mainly shown in the frontal lobe, which may reflect characteristic neuropathological changes of FTD, has not clearly demonstrated in foregoing studies and may be useful for early differential diagnosis of FTD. Further studies with large number of patients may be needed, but ^{1}H-MRS with 3.0 Tesla MR systems may be useful for investigation of degenerative process in neurodegenerative diseases.

Table: The metabolites ratio to Cr in Normal subjects, AD patients, FTD patients, and PSP patients. (Mean ± SD)

*: $p<0.05$ to Normal subjects, #: $p<0.05$ to AD patients, &: $p<0.05$ to FTD patients.

VOI		PC	PO	AC	Fr
NAA/Cr	Normal	1.14 ± 0.07	1.29 ± 0.11	1.12 ± 0.08	1.31 ± 0.13
	AD	***0.97 ± 0.06*** *	1.14 ± 0.15	1.03 ± 0.08	1.25 ± 0.18
	FTD	***1.03 ± 0.17*** *	1.21 ± 0.16	***0.97 ± 0.16*** *	***0.96 ± 0.30*** *
	PSP	1.03 ± 0.05	1.07 ± 0.23	1.07 ± 0.02	1.02 ± 0.35
Cho/Cr	Normal	0.18 ± 0.01	0.27 ± 0.04	0.26 ± 0.03	0.33 ± 0.04
	AD	0.19 ± 0.02	0.24 ± 0.03	0.24 ± 0.04	0.30 ± 0.06
	FTD	0.19 ± 0.03	0.25 ± 0.04	0.25 ± 0.01	0.25 ± 0.03
	PSP	0.16 ± 0.01	0.25 ± 0.02	0.24 ± 0.04	0.28 ± 0.06
mI/Cr	Normal	0.69 ± 0.06	0.70 ± 0.07	0.74 ± 0.08	0.73 ± 0.07
	AD	0.71 ± 0.09	0.73 ± 0.15	0.71 ± 0.13	0.79 ± 0.10
	FTD	***0.93 ± 0.25*** *	***0.92 ± 0.14*** * &	***0.96 ± 0.16*** * # &	***1.24 ± 0.26*** * # &
	PSP	0.64 ± 0.04	0.66 ± 0.06	0.65 ± 0.05	0.69 ± 0.01

Reference: 1 Kantarci K, Jack CR Jr, Xu YC et al. *Neurology* 55: 210–217.

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