What We Learned from Brain MR Study from the Sportology Project

KEIGO SHIMOJI*1) 2), YOSHIFUMI TAMURA*3) 4), TAKANORI UKA*5), MASAAMI HORI*1), KOJI KAMAGATA*1), HIROTAKA WATADA*3) 4), RYUZO KAWAMORI*3) 4), SHIGEKI AOKI*1)

*1)Department of Radiology, Juntendo University Graduate School of Medicine, Tokyo, Japan, *2)Department of Diagnostic Radiology, Tokyo Metropolitan Geriatric Hospital, Tokyo, Japan, *3) Department of Metabolism and Endocrinology, Juntendo University Graduate School of Medicine, Tokyo, Japan, *4) Sportology Center, Juntendo University Graduate School of Medicine, Tokyo, Japan, *5) Department of Neurophysiology, Juntendo University Graduate School of Medicine, Tokyo, Japan.

Although it is widely accepted that cerebrovascular events associated with diabetes mellitus adversely affect the brain, it is less well known that diabetes mellitus itself or even prediabetes can also do so. In this presentation, we focus on this issue by using evidence from recent diffusion tensor neuroimaging studies of patients with diabetes mellitus or metabolic syndrome.

First, through the Sportology project, we explored the regional patterns of white matter alteration in subjects with metabolic syndrome. We also investigated whether the degree of white matter alteration was correlated with BMI. Seven middle-aged men with metabolic syndrome and seven without metabolic syndrome underwent diffusion tensor imaging. MRI scans were performed with a 3.0-T unit (Achieva; Philips Medical Systems, Best, the Netherlands). We analyzed the resultant fractional anisotropy (FA) values by using a tract-based spatial statistics technique. We subsequently measured the mean FA values of the right inferior fronto-occipital fasciculus (IFOF) in all subjects by using a tract-specific analysis. We used Pearson’s correlation coefficient to evaluate the relationship between BMI and the mean FA value in the right IFOF. In the whole-brain analysis, subjects with metabolic syndrome had significantly lower FA values than control subjects in part of the right external capsule (which is part of the right IFOF), the entire corpus callosum, and part of the deep white matter of the right frontal lobe. In the regional brain analysis, the mean FA value of the right IFOF was 0.41±0.03 in subjects with metabolic syndrome and 0.44±0.05 in control subjects. A significant negative correlation was observed between BMI and FA values in the right IFOF (r = -0.56, p < 0.04). These results suggest that there are microstructural changes in the white matter of middle-aged individuals with metabolic syndrome. Our findings add to the increasing body of neuroimaging evidence on white matter alteration in patients with hypertension, diabetes, or metabolic syndrome. Microstructural alterations in the white matter of younger obese individuals may precede brain atrophy or cognitive impairment, or both, in advanced metabolic syndrome.

Second, again through the Sportology project, we explored the regional patterns of white matter alteration in 15 hypertensive middle-aged male participants and 11 normotensive controls by using diffusion kurtosis imaging (DKI) –based whole-brain analysis. DKI data were acquired by use of a single-shot, spin-echo planar imaging sequence. Mean diffusional kurtosis (MDK) values in many brain regions were higher in subjects with hypertension than in control subjects, indicating that there were widespread microstructural changes in the white matter, whereas the conventional diffusion metrics of FA did not differ significantly between subjects with hypertension and normal controls. Moreover, MDK values over the whole brain were significantly and positively correlated with systolic and diastolic blood pressure. This finding suggests that microstructural white matter changes occur in middle-aged men with hypertension, even before the onset of cerebrovascular disease. DKI might therefore be useful as a screening tool for risk of cerebrovascular disease.

DTI is completely noninvasive and is sensitive to white matter pathology in a number of disorders, including metabolic syndrome, in the human brain in vivo. Accumulated evidence highlights the need to further elucidate the relationship between metabolic syndrome and other neuronal mechanisms. A clear understanding of these relationships is crucial for managing patients with metabolic syndrome.