MR Imaging of Parkinson Disease: Review of Conventional and Advanced Techniques

Koji Kamagata[1], Masaaki Hori[1], Keigo Shimoji[1], Michimasa Suzuki[1], Atsushi Nakanishi[1], Hiroyuki Tomiyama[2], Yumiko Motoi[2], Issei Fukunaga[1], Humitaka Kumagai[1], Nobutaka Hattori[2], and Shigeki Aoki[1]

[1]Department of Radiology, Juntendo university, Tokyo, Japan, [2]Department of Neurology, Juntendo university, Tokyo, Japan

Purpose: Conventional MR imaging of Parkinson disease (PD) is frequently normal or nonspecific. However, advanced MR techniques, such as diffusion tensor imaging (DTI), diffusion kurtosis imaging (DKI), and arterial spin labeling (ASL) allow us to evaluate changes related to the pathophysiology of PD.[1-3] The purpose of this exhibit is to review the conventional and advanced MR imaging of PD and to present some new data from ASL and DKI studies of PD.

Outline of Content: 1. Review of conventional MR imaging of PD. 2. Advanced MR techniques for PD. 3. Review of our results of MR data sets of PD and age matched controls using DTI, DKI, ASL. Analysis of DTI includes ROI, tractography (tract specific analysis), Tract Based Spatial Statistics (TBSS).

Review of conventional and advanced MR imaging of Parkinson disease. DTI studies have shown that FA in the substantia nigra and some white matter tracts is reduced in PD compared to controls. DKI can detect alterations of the anterior cingulate fibers in PD more sensitively than can conventional DTI. Use of DKI can be expected to improve the ability to diagnose PD. ASL shows hypoperfusion in the precuneus in patients with PD. Advanced techniques such as DTI, DKI, and ASL may clarify pathophysiological changes of PD and help early diagnosis of PD.
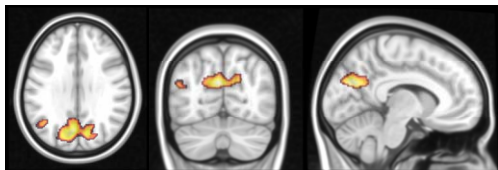

Fig. 1 Maximum intensity projection of Statistical parametric mapping results ($P < 0.001$ uncorrected). The shaded areas indicate the level of the calculated t statistic, and represent areas where there is a decrease in regional blood flow in PD compared with controls.

Our ASL study.

Subjects: Twenty-eight PD patients without dementia and 28 normal controls were scanned by using a quantitative ASL method with a 3T MRI unit. **Results:** PD patients showed lower regional cerebral blood flow in the bilateral precuneus than normal controls (Fig. 1). **Conclusion:** It is possible to confirm the areas of cerebral hypoperfusion in PD patients with the ASL method by using statistical image analysis. This method can be used as a noninvasive tool for diagnosis and pathological evaluation of PD.

Our DKI study.

Subjects: Seventeen patients with PD without dementia and 15 age-matched controls.

Results: Mean kurtosis (MK) and FA in the anterior cingulate fiber tracts (CFTs) were significantly lower in PD patients than in healthy controls (Fig. 2). The area under the ROC curve was 0.912 for MK and 0.747 for FA in the anterior CFTs. MK in the anterior CFTs had the best diagnostic performance (mean cutoff, 0.967; sensitivity, 0.87; specificity, 0.94).

Conclusions: DKI can detect alterations of the anterior cingulate fibres in PD patients more sensitively than can conventional DTI. Use of DKI can be expected to improve the ability to diagnose PD.
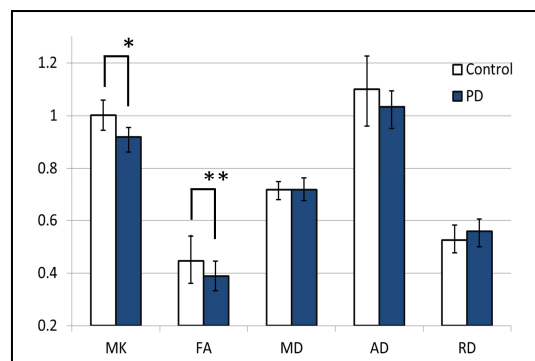

Fig. 2 Mean and standard deviation of diffusion parameters measured in anterior CFTs. Blue bars represent patients with PD and white bars represent healthy controls.
* = Differences between patients and control subjects were significant ($P = 0.000056$).
** = Differences between patients and control subjects were significant ($P = 0.017$).

References: 1. Kamagata K, Motoi Y, Abe O, et al. AJNR. 2012; 33:890–895. 2 Kamagata K, Motoi Y, Hori M, et al. J Magn Reson Imaging. 2011;33:803–807. 3. Wang JJ, Lin WY, Lu CS, et al. Radiology. 2011;261:210–217.