

Diagnostic Values of Diffusion Weighted Imaging for Differentiating Multiple System Atrophy from Parkinson's Disease

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Abstract:

We investigated apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values using diffusion weighted imaging (DWI) MRI in multiple system atrophy (MSA) and Parkinson's disease (PD) to assess the differential diagnostic values. Differentiation of MSA from PD is clinically important because these disorders manifest dissimilar treatment response and prognosis. Recently, quantitative analysis of DWI associated values was reported to be useful for detecting the early imaging changes of MSA. We measured ADC and FA values in the pons, bilateral middle cerebellar peduncle and putamen comparing MSA and PD patients. We placed circular shaped regions of interest (ROI) in the each area. Subjects were 10 probable MSA patients (mean age 66 years, mean disease duration 5.5 years) and 15 Parkinson's disease patients (mean age 70 years, mean disease duration 8.1 years). Normal Heart/ Mediastinum ratio of cardiac MIBG scintigraphy was applied to confirm the further supporting evidence of MSA. ADC values in the all ROIs of pons, middle cerebellar peduncle, and putamen indicated significantly higher in MSA than PD. ADC values averaging all ROIs seemed best to discriminate MSA from PD. ADC values tend to be higher correlating with longer disease duration and severer clinical symptoms in MSA patients. We found no significant correlation with disease duration nor severity in PD patients. FA values in MSA patients showed lower in the pons and middle cerebellar peduncle, but in the putamen compared with PD. Lower FA values in the pons and middle cerebellar peduncle were detected as longer duration and severer symptoms in MSA. ADC and FA values in the brainstem and putamen of MSA patients were revealed to differ from PD. The changes of these values tended to be evident in the more advanced MSA patients, suggesting these quantitative manners might reflect pathological progression in MSA. DWI appears to be a useful diagnostic tool for differential diagnosis of MSA from PD.

Keywords: Multiple system atrophy, Diffusion weighted imaging, Apparent diffusion coefficient, Fractional anisotropy (FA)

Introduction:

Differentiation of parkinsonian variant of multiple system atrophy (MSA) from Parkinson's disease (PD) is clinically important because these disorders manifest dissimilar treatment response and prognosis. Characteristic MRI findings of MSA, such as dorsolateral putaminal hyperintensity (DPH) or hot cross bun (HCB) sign, were not always obvious especially in the early stage of the disease. Recently, quantitative analysis of diffusion weighted imaging (DWI) associated values were reported to be useful for detecting the early imaging changes of MSA. We therefore investigated apparent diffusion coefficient (ADC) and fractional anisotropy (FA) values using DWI methods in MSA and PD to assess the differential diagnostic values.

Methods:

Subjects were 10 probable MSA cases (mean age 65.4 years, mean disease duration 5.5 years) and 15 PD cases (mean age 70.1 years, mean disease duration 8.1 years). Table 1 summarized profiles of subjects including Hohen-Yahr (H-Y) stages. H-Y stages were supposedly applied for the estimation of motor

Characteristics of subjects		
	MSA	PD
No.	10	15
M/F	7/3	7/8
Age	65.4 (8.0)	70.1 (8.3)
Duration	5.5 (4.3)	8.1 (5.1)
H-Y stages	3.7 (0.9)	3.5 (0.7)

Table 1 Characteristics of subjects

disability of MSA cases in order to make a rough comparison. Profiles of both groups were well matched and statistical significant differences were not evident. Normal Heart/Mediastinum (H/M) ratio of cardiac MIBG (meta-iodobenzylguanidine) scintigraphy was also applied to confirm the further supporting evidence for MSA (Fig. 1). On the other hand, H/M

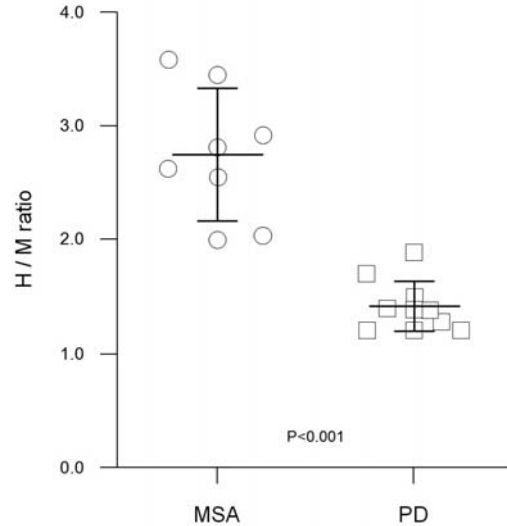


Fig. 1 H/M ratio of cardiac MIBG scintigraphy: MSA vs. PD
Normal H/M > 2.0

ratio in PA tended to decrease lower than 1.8. We measured regional ADC (rADC) and regional FA (rFA) values in the pons, bilateral middle cerebellar peduncles (MCP) and putamens comparing MSA and PD cases. We performed with 1.5 T MR scanner (TR/TE=3000/60, b=1000, Siemens, Germany) and circular shaped regions of interest (ROI) were placed in the each areas (Fig. 2).

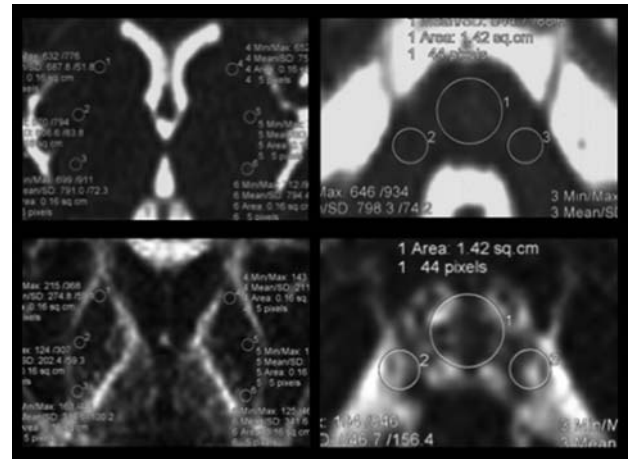


Fig. 2 ROIs placed in each area in MRI
Upper left: ROIs for putamens in ADC image
Upper right: ROIs for pons and MCPs in ADC image
Lower left: ROIs for putamens in FA image
Lower right: ROIs for pons and MCPs in FA image
※ Values averaging in 6 ROIs for putamen
※※ Values averaging in 3 ROIs pons and MCPs for pons

Results:

ADC values averaging the each ROIs of pons (pons and MCPs) and putamens (bilateral putamens) indicated significantly higher in MSA than PD (Fig. 3). ADC values averaging all ROIs seemed best to discriminate MSA from PD. FA values in MSA patients showed lower in the pons, but in the putamens com-

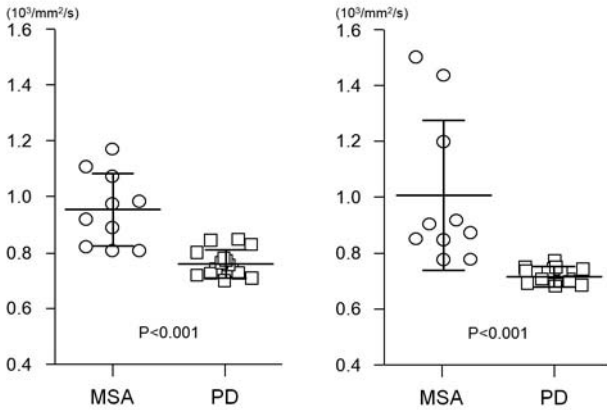


Fig. 3 rADC values in MSA vs. PD
Left: Putaminal rADC, Right: Pontine rADC

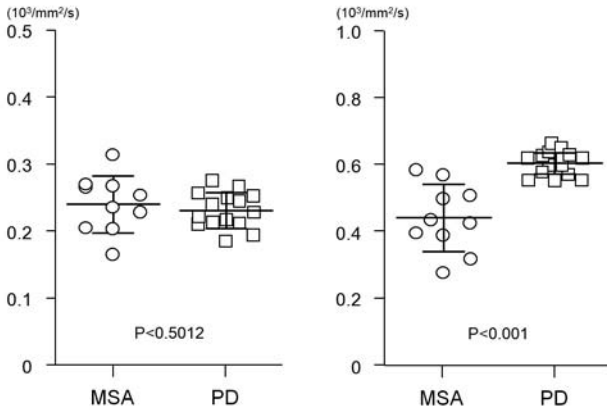


Fig. 4 rFA values in MSA vs. PD
Left: Putaminal rADC, Right: Pontine rADC

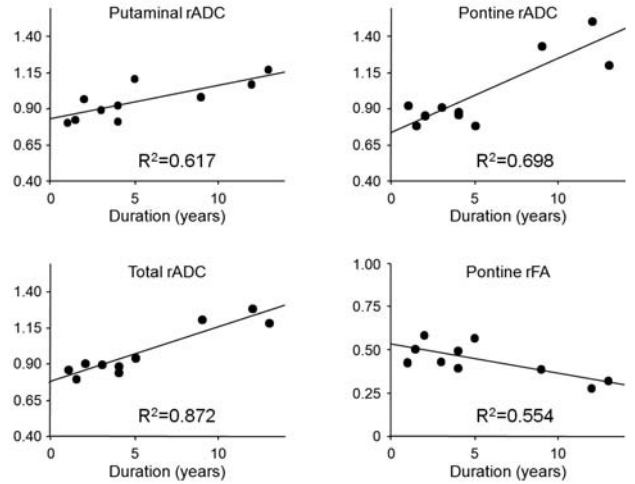


Fig. 5 rADC and rFA in relation to the duration of MSA

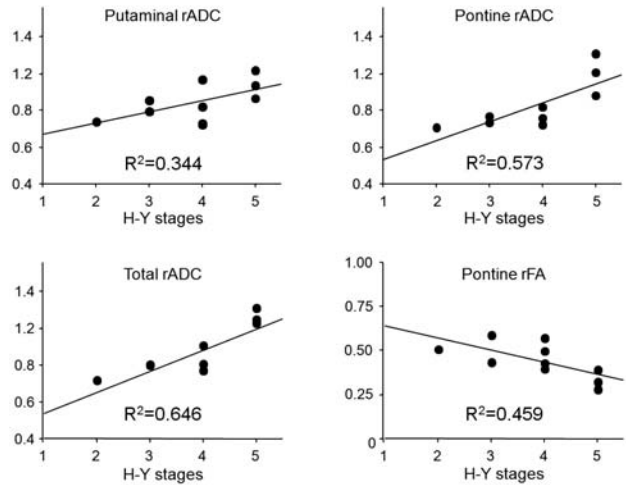


Fig. 6 rADC and rFA in relation to motor disability (H-Y) of MSA

pared with PD (Fig. 4). ADC values tend to be higher correlating with longer disease duration and severer motor symptoms in MSA patients (Fig. 5). No significant correlation with disease duration nor severity in PD patients (not shown). Lower FA values in the pons were detected as longer duration and severer motor symptoms in MSA (Fig. 6).

Discussion:

Conventional MRI changes suggesting MSA such as DPH or HCB sign reportedly fail to distinguish MSA from PD up to nearly half of early staged cases¹. Reduction of H/M ratio of cardiac MIBG scintigraphy is proven to be useful for diagnosing PD, but the decision must be cautious since some cases of MSA also show the diminished ratio. Köllensperger described that DWI was superior to MIBG scintigraphy in the differential diagnosis of parkinsonian variant of MSA versus PD². Several investigators have indicated clinical advantages of DWI utilizing ADC and/or FA values in discriminating MSA from PD²⁻⁶. DWI values can detect early pathological involvement prior to conventional MRI in MSA. Ito demonstrated combined analysis of both ADC and FA values in all ROIs including pons, cerebellum and putamen, was more useful than only one⁴. Our data also supported the similar tendency.

These alterations of DWI values in brainstem could be detected even in parkinsonian variant of MSA. Subtle early degenerative changes in brainstem may explain these results. We showed that increased total ADC and reduced pontine FA values were correlated well with the disease duration and motor severity. Quantitative DWI values may provide potent markers of disease progression.

Conclusions:

ADC and FA values in pons and putamen of MSA patients were revealed to differ from PD. The changes of these values tended to be evident in the more advanced MSA patients, suggesting these quantitative manners might reflect pathological progression in MSA. DWI appears to be a useful diagnostic tool for differential diagnosis of MSA from PD.

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