Quantitative SWI in differentiation of MSA and Parkinson's disease

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Introduction: Idiopathic Parkinson's disease (IPD) and multiple system atrophy (MSA) are two most prevalent neurodegenerative movement disorders in which increased iron is thought to accumulate in the striatum. The purpose of this study is to measure the phase shift value, which corresponds to iron deposition [1], in basal ganglia so as to determine its value in differentiation between MSA and IPD.

Methods: According to the published criteria [2,3], 21 patients (M:F=14:7, aged 64.00±8.75 years) with MSA (disease duration of 2.6±1.8 years), 20 patients (M:F=13:7, aged 62.90±13.6 years) with IPD (disease duration of 5.2±2.5 years), and 9 age-matched healthy volunteers (M:F=6:3, aged 64.44±6.15 years) were recruited in our study. All subjects underwent MRI on a 3-Tesla scanner (Signa VH/*i*, Excite, GE). A susceptibility-weighted imaging (SWI) sequence was performed (3D-FSPGR, TR=29ms, TE=10ms, flip angle=15, NEX=0.75, Matrix=384*320) after conventional brain MRI examination. Data post-processing was applied using a SWI analysis software package according to Sehgal's method [4] based on the Functool platform of the AW workstation (version 4.2). By using a phase filter, both magnitude and phase images were obtained. An experienced radiologist blind to the clinical diagnosis, applied region of interest (ROI) on phase images to measure the phase shift value of bilateral globus pallidus (30 pixels), putamen (80 pixels), and caudate (varies, covering its anatomic contour) respectively. The regions were drawn bilaterally in the area of maximum apparent phase shift (darkest on phase image) located within each anatomic structure of interest compared with consecutive slices (slice thickness=2.5mm/gap=0mm) (Fig. A, B). The shape of the region varied among the anatomic structures. Values were recorded and statistical analysis was done with SAS (version 8.2, Institute, Cary, NC). Student *t* test was performed for comparison of quantitative independent variables between groups. Significance was defined as $p<0.05$.

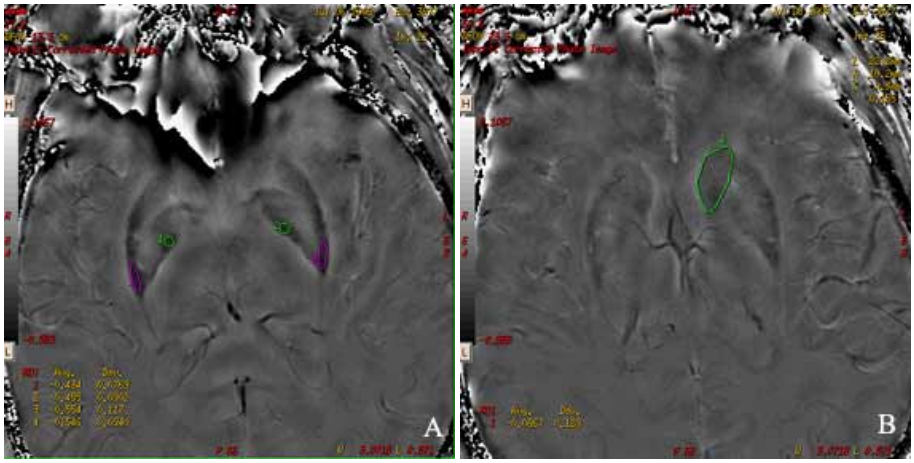

Fig. A, B, corrected phase shift images
Fig. A, showed ROIs placement in bilateral globus pallidus and dorsolateral putamen;
Fig. B, showed ROI placement at caudate,

Results: The age showed no significant difference among the three groups at the time of MRI examination. Mean phase shift value at each region in all groups was shown in Table 1. Mean phase shift value at putamen in MSA group was significantly lower than that of IPD group or control group (left $t=-3.52$, $p=0.0016$; right $t=-2.87$, $p=0.0074$, with IPD) (left $t=3.10$, $p=0.0049$; right $t=2.54$, $p=0.0184$, with controls). Values at globus pallidus and caudate in MSA group were not significantly different from those of other groups. The mean phase shift values showed no statistical difference between IPD group and control group at all regions.

Table 1. Summery of phase shift (mean ± SD) of each region in patients and controls

	Globus Pallidus		Putamen		Caudate	
	left	**right**	**left**	**right**	**left**	**right**
MSA	−0.207 ± 0.14	−0.206 ± 0.14	−0.290 ± 0.14	−0.274 ± 0.24	−0.043 ± 0.04	−0.040 ± 0.04
IPD	−0.305 ± 0.21	−0.289 ± 0.19	−0.104 ± 0.09	−0.105 ± 0.12	−0.039 ± 0.06	−0.038 ± 0.06
Control	−0.470 ± 0.48	−0.383 ± 0.49	−0.131 ± 0.05	−0.137 ± 0.05	−0.037 ± 0.03	−0.032 ± 0.01

Discussion and Conclusion: Several methods attempt to quantify brain iron using MRI. Ogg et al have shown that phase and iron content correlate with age, and suggested that phase shift will be one of the most accurate means to map iron content [1]. SWI has been designed to acquire phase and magnitude data separately, allowing flexible and offline post-processing, thus providing not only a high-resolution, three-dimensional, fully velocity compensated gradient echo sequence, but also a quantitative method in analyzing the abnormal iron deposition in related movement disorders. In this study, larger ROIs were chosen to avoid big value deviation in caudate since phase shift varies greatly in that region. As for putamen and globus pallidus, fixed-shaped ROIs with fixed pixels were chosen to ensure the consistency of the measurement. Our results quantitatively confirmed previous studies that abnormal iron accumulation is mostly in bilateral dorsolateral putamen in patients with MSA. Further study with large sample size is necessary to validate the method for clinical application.

Reference:

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