Demyelination of subcortical nuclei in multiple sclerosis

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Abstract. Myelin containing in basal ganglia in multiple sclerosis patients was evaluated using new noninvasive quantitative MRI method fast whole brain macromolecular proton fraction mapping. Myelin level in globus pallidus and putamen significantly decreased in multiple sclerosis patients as compared with healthy control subjects but not in substantia nigra and caudate nucleus.
Key words: multiple sclerosis, macromolecular proton fraction, demyelination, magnetic resonance imaging, subcortical gray matter.

1. Introduction

Multiple sclerosis was used to determine as white matter disease because plaques, main marker of MS, were clearly visualized [1]. At present it was obvious that gray matter damage which was poorly detectable using conventional MRI method occurred at the first stage of MS and correlated with clinical symptoms (both motor and cognitive) [2]–[4] Subcortical gray matter involvement in MS pathology was also observed [2], [5]but still need to be studied. In our research, basal ganglia demyelination in MS patients was evaluated using fast mapping of macromolecular proton fraction (MPF). The method of fast MPF mapping was developed by Yarnykh [6] and based on the magnetization transfer effect. Of note, relaxation-based MRI methods [7]–[9] are highly sensitive to paramagnetic ions and hardly appropriate for the assessment of demyelination in structures with high iron content, such as basal ganglia In contrast, MPF mapping is a highly-accurate quantitative method insensitive to iron and, therefore, very suitable for studying demyelination in gray matter in MS.

We present the results of secondary analysis of earlier published data [4] aimed to identify the effect of demyelination on MPF in subcortical gray matter structures in MS.

2. Methods

3D MPF maps were obtained using 3T MRI scanner from 30 MS patients and 17 healthy control subjects. Detailed characteristics of the study population can be found elsewhere [4]. Caudate nucleus, putamen, globus pallidus and substantia nigra were outlined on MPF maps. Mean MPF values in each structure were calculated as average measurements within contours weighted by the contour area and

then averaged between hemispheres. MPF values in each structure were compared between healthy control participants and MS patients using independent samples t-test ($p<0.05$).

3. Results

MPF values in the globus pallidus and putamen were significantly lower in the MS group as compared to the healthy control group ($p=0.008$ and $p=0.004$ respectively). The group differences between MPF in caudate nucleus and substantia nigra were not significant, though the trend of MPF decrease was observed (Table 1).

Table 1. Mean value of MPF in subcortical structures in control and MS groups

Structure	MS group	Control group	p
Caudate nucleus	6.997	7.131	0.238
Globus pallidus	9.656	10.150	0.001*
Putamen	7.129	7.508	0.001*
Substantia nigra	8.906	9.137	0.124

* Statistically significant changes of MPF value in subcortical structures in MS patients in compared with healthy volunteers.

In conclusion, subcortical structures in MS had different degree of myelin loss. The most demyelinated structures were the globus pallidus and putamen, but substantia nigra and caudate nucleus were minimally affected.

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