

Distinct pattern of atrophy in the different phenotypes of progressive supranuclear palsy in magnetic resonance imaging

A. Gröger¹, K. Srulijes¹, M. Nechyporenko¹, E. Dietzel¹, C. Mänz², U. Klose², W. Mätzler¹, and D. Berg¹

¹Department of Neurodegeneration, Hertie Institute for Clinical Brain Research, University Tuebingen, Tuebingen, Germany, ²Department of Diagnostic and Interventional Neuroradiology, University Hospital Tuebingen, Tuebingen, Germany

Introduction

Progressive supranuclear palsy is a clinically heterogeneous neurodegenerative disease and neuropathological characterized by neuronal loss and glial lesions composed of abnormal aggregates of tau protein (1). Magnetic resonance imaging and diffusion tensor imaging can be used to assess the neurodegenerative processes *in vivo* by analyzing morphological variations and changes in the fractional anisotropy and mean diffusivity (2). Many morphological studies described the typical midbrain atrophy patterns in patients with progressive supranuclear palsy; however it seems to be not a necessary marker (3), (4), (5). The goal of this study was to investigate whether the presence or absence of the midbrain atrophy patterns can be used to differentiate PSP subtypes *in vivo*.

Material and Methods

19 patients with two different clinical phenotypes of progressive supranuclear palsy were examined at 1.5 T. All patients were rated by visual inspection for presenting the typically morphological midbrain atrophy patterns. According to this rating the patients were arranged into two subgroups (Fig. 1). Morphological differences and variations in the tissue microstructures were studied using voxel-based morphometric and diffusion tensor imaging data.

Results

With clear inter-reader agreement, the morphological midbrain patterns were found only in 12 patients (group A). In six patients these signs lacked (group B). In the regions-of-interest based analyses the midbrain volumes were significantly smaller and the third ventricle larger in A than in B. The values of mean diffusivity were larger and fractional anisotropy smaller in A than in B. Significant inter-group differences between A and B were found in 12 clusters but only for grey matter probability A>B, white matter probability A<B, and liquor probability A>B. Significantly larger grey matter volumes were found for A (Fig. 2) in the cingulate gyrus, cerebellum, putamen, and inferior temporal gyrus compared to group B. The white matter volumes in A were significantly decreased in the midbrain and pre-/postcentral gyrus compared to B. The liquor volumes of the third ventricle and in the frontal regions were significantly increased in A than in B (Tab. 1). Furthermore, the values of mean diffusivity in A were significantly elevated in 10 clusters and of fractional anisotropy were significantly reduced in 15 clusters spread out over the entire brain compared to B. In contrast no significant cluster of decreased mean diffusivity and increased fractional anisotropy values were found in A compared to B.

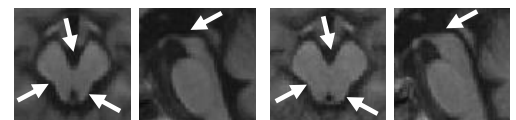


Fig. 1: Mean T1-weighted images from the midbrain in the axial and mid-sagittal planes. Group A (up, left) shows more distinct midbrain atrophy than group B (up, right).

Tab. 1: Mean values for the total intracranial grey matter, white matter, and cerebrospinal fluid volumes in group A and B from the cluster analysis. GM = grey matter, WM = white matter, CSF = cerebrospinal fluid.

	GM cerebellum (cm ³)	GM cerebellum (cm ³)	GM inferior temporal gyrus (cm ³)	GM posterior cingulate (cm ³)	GM posterior cingulate (cm ³)	GM putamen (cm ³)	WM midbrain (cm ³)	WM pre-/postcentral gyrus (cm ³)	CSF third ventricle (cm ³)
group A	3.432 ± 0.067	1.173 ± 0.047	0.903 ± 0.053	1.883 ± 0.078	1.442 ± 0.092	2.624 ± 0.089	2.094 ± 0.263	0.822 ± 0.149	7.362 ± 0.548
group B	3.224 ± 0.116	1.050 ± 0.064	0.738 ± 0.050	1.669 ± 0.182	1.198 ± 0.170	2.458 ± 0.092	3.031 ± 0.301	1.082 ± 0.122	5.507 ± 0.802
p value	0.005	0.003	0.000	0.033	0.015	0.005	0.000	0.001	0.001

Discussion

It is possible to differentiate clinical phenotypes of progressive supranuclear palsy *in vivo* by magnetic resonance imaging. The morphological midbrain atrophy patterns seem to be typical only for group A (Richardson's syndrome) whereas the findings in group B (progressive supranuclear palsy-parkinsonism) were nonspecific. Furthermore, it can be concluded that in group A the degeneration of white matter is pronounced what leads to a relatively fast loss of nervous fibre tracts with strong clinical symptoms and relatively short disease duration until the death. In the opposite in group B the degeneration of grey matter is pronounced and compensation effects can reduce clinical symptoms. When the degeneration of grey matter is more progressive the degeneration of white matter will be increased which leads to a loss of nervous fibre tracts with more clinical symptoms. This fact could explain the milder and longer disease duration until the death as well as the convergence in the clinical symptoms with disease duration.

References

1. Dickson DW et al., *Curr Opin Neurol* 2010;23(4):394-400.
2. Padovani A et al., *J Neurol Neurosurg Psychiatry* 2006;77(4):457-463.
3. Adachi M et al., *Magn Reson Med Sci* 2004;3(3):125-132.
4. Adachi M et al., *Radiat Med* 2006;24(8):568-572.
5. Park HK et al., *Mov Disord* 2009;24(2):237-245.

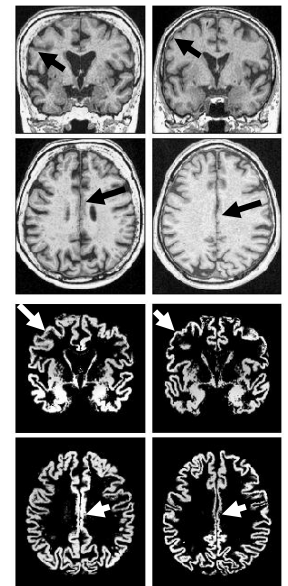


Fig. 2: Differences in the cortical thickness between typical patients from group A (left) and group B (right). Shown are the coronal and transversal T1-weighted images and the coronal and transversal grey matter segmentations.