# Segmentation studies in parkinsonism

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**Introduction**

Parkinsonian disorders are often difficult to diagnose and distinguish from each other clinically and the use of MR techniques as a diagnostic tool has been the subject of many studies. In three recent studies [1-3] segmentation and voxel-based morphometry have been used to investigate brain morphology in parkinsonism. In the present work patients with Parkinson's disease (PD) and the Parkinson variant of multiple system atrophy (MSA,p) were studied with whole brain segmentation of MR images followed by designation of anatomical regions.

**Patients and MRI protocol**

10 patients with MSA,p (4 possible, 6 probable, 8 males, 2 females), 20 sex and age matched patients with PD (15 males, 5 females) and 18 sex and age matched controls (14 males, 4 females) were included in the study. Patients all fulfilled clinical research criteria for MSA and PD respectively. Mean(Std) Hoehn and Yahr score (H&Y) was 2.3(1) and 3.2(0.9) in the PD and MSA groups respectively and mean(Std) duration of disease was 8.4(5.5) and 4.6(1.8) in the PD and MSA groups respectively.

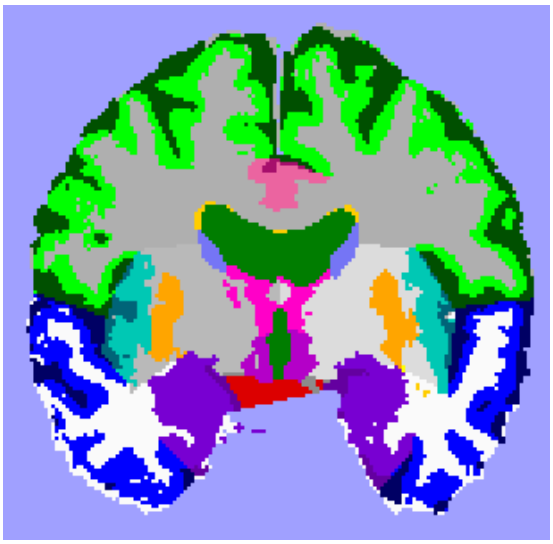
MR imaging was performed in a Siemens Magnetom Vision 1.5 T scanner (Siemens AG, Erlangen, Germany) using the standard head coil. Two whole-brain image series were acquired: T1 weighted gradient echo (MPRAGE) sequence in the sagittal plane with TR = 9,7 ms, TE = 4 ms, flip angle = 12 degrees, FoV = (250 x 250) mm, matrix = (256 x 256) mm and slab thickness = 170 mm giving a voxel size of (0,98 x 0,98 x 1,00) mm. Proton density and T2 weighted spin-echo sequence with TR = 5000 ms, TE = 80/20 ms, FoV = 230 mm, matrix (256 x 256) mm, 52 slices and slice thickness 4 mm giving a voxel size of 0,9 x 0,9 x 4 mm. The slices were oriented paracoronally perpendicular to the intercommisural line located on the mid-brain slice of the MPRAGE sequence.

**Image analysis and statistics**

Images were analyzed using a previously described method [4]. The Pd and T2 weighted image sets were segmented by voxel classification and anatomical regions were designated manually by the same anatomist who was blinded to the clinical diagnosis, age and gender of the subject.

An example of a segmented brain slice from a 58 year old man with Parkinson's disease is shown in the figure.

The following regions were chosen for analysis: Ventricles, caudate nuclei, putamina, thalamus, substantia nigra, amygdala, frontal lobe and cerebellar grey and white matter, brainstem and white matter lesions (WML). Paired t-tests comparing region volumes from the two sides showed significant differences between the two sides as often in the control group as in the patient groups. This may be due to inherent biological asymmetries of the brain that can be difficult to distinguish from asymmetries due to disease. For this reason volumes from the two sides were summed. In order to compensate for differences in head size supratentorial and infratentorial region volumes were divided by total supratentorial and infratentorial intracranial volumes respectively. The relative region volumes were analyzed using backward multiple regression analysis with diagnosis, sex, age and H&Y as independent variables and regional brain volume as outcome. H&Y was excluded from the final model since it was not significant for any of the volumes that were analyzed. The level of significance was set at $p < 0.05$.




**Results**

In the following all volumes of regions referred to are relative to intracranial volumes as described above. No significant differences in region volumes were found between the two patient groups. Volumes of putamina, substantia nigra and amygdala were significantly smaller in patients than in controls and caudate nuclei volumes were significantly smaller in MSA,p patients than in controls. Ventricle and WML volume increased significantly with age whereas frontal and cerebellar grey matter volumes decreased significantly with age. Caudate volume was significantly larger in woman than in men.

**Discussion**

The findings of decreased volumes of putamina and caudate nuclei in patients with PD and MSA is in agreement with previous findings [1-2] and so is the finding of decreased volume of substantia nigra in the patient groups. Studies describing segmentation of the substantia nigra have not been reported previously but proved successful as a diagnostic tool in parkinsonism. Decreased volume of the amygdala has earlier been demonstrated in patients with PD [5] but it has not been demonstrated in MSA patients before. Segmentation of the frontal lobes has only been done in the two most recent studies [2-3]. Brenneis et al. [2] found atrophy in cortical subregions of the frontal lobe of patients with MSA,p but not in patients with PD. These subtle changes may be overlooked in our study since we have not been looking at subregions of the frontal lobe. Our finding of normal frontal lobe volume in patients with PD confirms the results of Brenneis et al. [2]. The significant differences in basal ganglia, cerebellar and brainstem volumes between patients with PD and MSA,p. described in previous studies [1-2] could not be reproduced in our study. This may be due to the fact that most of the the patients with PD had much longer duration of disease than the MSA,p patients.

**Conclusion** Segmentation of subcortical nuclei including the substantia nigra is a useful tool in the diagnosis of parkinsonism.

**References** **1.** Schulz JB et al. Ann Neurol 1999; 45(1):65-74. **2.** Brenneis C et al. Mov Disord 2003; 18(10):1132-1138. **3.** Specht K et al. Arch Neurol 2003; 60(10):1431-1435. **4.** Jernigan TL et al. Neurobiol Aging 2001; 22(4):581-594. **5.** Harding AJ et al. Brain 2002; 125(Pt 11):2431-2445.