Putaminal Diffusion Imaging for the Differential Diagnosis of the Parkinson Variant of Multiple System Atrophy from Parkinson’s Disease: Impact of Segmentation Accuracy

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Background

The discrimination between Parkinson’s disease (PD) and the Parkinson variant of multiple system atrophy (MSA-P) may be challenging in early disease stages due to high clinical overlap[1]. Differences in prognosis and therapy as well as research bias make an early diagnosis desirable. It has been shown that putaminal diffusion imaging represents a useful diagnostic tool to discriminate PD from MSA-P [2, 3]. Some studies however were not able to confirm the role of this technique as suitable discriminator, although heterogeneity exists in the segmentation of the putamen across the studies [4, 5].

Aim: To evaluate different approaches of segmentation of the putamen to discriminate PD from MSA-P based on putaminal diffusivity values.

Methods

Patient demographics and clinical characteristics are summarized in table 1. Different approaches to define the region of interest (ROI) were applied by two blinded raters: small and large circular ROIs were manually placed in the anterior and posterior putamen (PUT 1-4, fig. 1). Moreover, the whole putamen (PUT 5) was segmented as well as the putamen on Foramen Monroi level (PUT 6). Mean apparent diffusion coefficient (ADC)-values of the 3 groups were compared. Diagnostic accuracy for each type of segmentation was estimated using receiver operating characteristic (ROC) analysis.

<table>
<thead>
<tr>
<th>PUT 1</th>
<th>PUT 2</th>
<th>PUT 3</th>
<th>PUT 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="PUT 1" /></td>
<td><img src="image2.png" alt="PUT 2" /></td>
<td><img src="image3.png" alt="PUT 3" /></td>
<td><img src="image4.png" alt="PUT 4" /></td>
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</tbody>
</table>

Fig. 1. Different approaches in the definition of the ROIs; PUT 1: small (9,69 mm²) circular ROI in the anterior putamen; PUT 2: large (41,97 mm²) circular ROI in the anterior putamen; PUT 3: small circular ROI in the posterior putamen; PUT 4: three small circular ROIs medial to the external capsule, according to Prodhoel et al. [6]

Table 1. Demographic, clinical and imaging data of the study population: *Chi-square tests; **Univariate ANOVA; *** Kruskal-Wallis test

<table>
<thead>
<tr>
<th>Sex (F/M)</th>
<th>Age (mean ± SD)</th>
<th>Disease duration (mean ± SD)</th>
<th>UPDRS-III (mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n=61</td>
<td>67,86 ± 8,47</td>
<td>5,79 ± 5,73</td>
<td>18,6 ± 7,5</td>
</tr>
<tr>
<td>n=24</td>
<td>65,4 ± 9,5</td>
<td>2,88 ± 2,46</td>
<td>29,5 ± 9,5</td>
</tr>
<tr>
<td>n=30</td>
<td>66,5 ± 7,26</td>
<td>n.a.</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

Table 1. Demographic, clinical and imaging data of the study population

Results

Significantly increased putaminal diffusivity values ($p < 0.001$) were found in all but the small anterior ROI (PUT 1) in MSA-P versus PD and HC. In ROC analysis best discrimination (area under the curve >0.9) was reached for the small ROI located in the posterior putamen (PUT 3), for the entire putamen (PUT 5) and for the putamen on Foramen Monroi level (PUT 6). Discrimination was worse if ROIs were placed in the anterior part of the putamen (PUT 1 and 2).

Conclusions

The segmentation procedure seems to considerably influence the discriminative ability of putaminal diffusion imaging in the differential diagnosis between PD and MSA-P. In our study best discrimination is reached either by placing a ROI in the posterior putamen, by segmenting the putamen as a whole or by segmenting the putamen on the Foramen Monroi level.

References