Deficits in automatic postural responses are related to cerebellar involvement in people with multiple sclerosis

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Introduction

To what extent are balance impairments in people with multiple sclerosis (PwMS) due to cerebellar deficits?

Although neurorehabilitation has been recommended to improve balance in PwMS, the extent to which the cerebellum is responsible for improving and retaining improvements in postural responses to external perturbations is unknown.

Studies have reported an important role of the cerebellum in motor learning but little is known about the impact of cerebellar deficits on postural control and in relearning postural responses in PwMS.

The current study aimed to:
- Determine the relationship between cerebellar white matter tract integrity and ataxia rating scales.
- Identify the relationship between cerebellar white matter integrity and motor learning of postural responses.

Neuroimaging

Diffusion Weighted Images were collected on a 3.0T Siemens Tim Trio scanner
- b = 1000 s/mm²
- 90 non-collinear directions
- Associations between radial diffusivity of the cerebellar peduncles and the following measures were assessed:
  - International Cooperative Ataxia Rating Scale (ICARS)
  - Spatial (gain) postural motor learning measures

Participants

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<tr>
<th></th>
<th>HC</th>
<th>PwMS</th>
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<tbody>
<tr>
<td>Age</td>
<td>46.5 (13.8)</td>
<td>47.6 (10.6)</td>
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<tr>
<td>M/F</td>
<td>3/11</td>
<td>3/10</td>
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<tr>
<td>EDSS</td>
<td>NA</td>
<td>3-4</td>
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<td>Disease Duration</td>
<td>13.5 (8.5)</td>
<td>16.53 (10.2)</td>
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<tr>
<td>ICARS (max=100)</td>
<td>N/A</td>
<td>16.53</td>
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Figure 1 – Experimental Paradigm: Continuous Surface Perturbations

Figure 2 – MS impairs spatial learning and retention of postural responses

Figure 3 – Cerebellar pedunlce regions of interest

Visualization of superior (blue), middle (green) and inferior (red) cerebellar peduncles. Peduncles were identified from the Johns Hopkins University DTI-based ICBM-DTI-81 white-matter labels atlas. Microstructural integrity of white matter within all peduncles was assessed by radial diffusivity as it has been shown to be an indirect, in vivo marker of myelination.

Figure 4 – Cerebellar peduncle radial diffusivity was higher for PwMS than the Control group

Figure 5 – Cerebellar peduncle radial diffusivity was not related to baseline performance and retention of postural control

Conclusions & Interpretations

- Reduced white matter integrity of cerebellar peduncles is related to clinical ataxia.
- White matter integrity of cerebellar peduncles is affected in PwMS.
- However, reduced white matter integrity of cerebellar peduncles did not affect the retention of postural motor learning responses.

Our results indicate that PwMS with worse cerebellar connectivity demonstrate clinical ataxia. However, poorer integrity of the white matter does not seem to affect retention of postural motor learning responses.

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