Theme: Imaging Research in Basic and Clinical Science: Neuroscience, Cardiology and Oncology

Strengthening of short-range connections in thalamic nuclei in early multiple sclerosis is related with disability and cognitive decline

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Abstract:
Multiple sclerosis (MS) is a central nervous system disease characterized by demyelinating and inflammatory lesions in white matter, with loss in microstructural properties of white matter fiber pathways, which can cause cognitive impairment and disability from an early stage. MS can be viewed as a disconnection disease, where structural connectivity between gray matter regions is altered, mainly in long-range connections, what can be studied with diffusion-weighted imaging (DWI). Here we used longitudinal DWI data of patients with early relapsing-remitting MS and sex-age-matched healthy controls to model whole brain structural connectivity using graph theory metrics, with regions from the Automated Anatomic Labelling Atlas 3. Patients' disability and neurocognitive function were evaluated with the expanded disability status scale (EDSS) and the symbol digits modality test (SDMT), respectively. Data were acquired in a 3T MRI system with a multi-shell diffusion protocol at two timepoints (baseline, when patients were diagnosed, and follow-up, ten months after), graph theory metrics were estimated using the brain connectivity toolbox, and EDSS and SMDT scores were correlated with local and global connectivity metrics to assess relationships between structural connectivity and cognitive/clinical outcomes. At baseline, SDMT positively correlated with density of connections and negatively correlated with local clustering and strength in thalamic nuclei. On the other hand, EDSS positively correlated with local strength, clustering and efficiency, also in thalamic nuclei. At follow-up, while SDMT showed no correlations with thalamic nuclei, EDSS still presented positive correlations with clustering and strength of connections. These results seem to point towards a strengthening of short-distance connections in thalamic nuclei in early MS, reflecting a maladaptive mechanism, as these scores worsen with increased strength, efficiency, and clustering.

Keywords: Diffusion-Weighted Imaging, Multiple Sclerosis, Structural connectivity, Graph theory