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Continuous reorganisation of cortical information flow in MS patients: a longitudinal effective connectivity study

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Background: Brain reorganisation processes are essential for the long-term outcome in patients with multiple sclerosis (MS). Effective connectivity (EC) as derived from functional MRI, can be analysed to estimate reorganisation processes and directional information flows between cortical regions. These measures could provide the missing link for modelling the long-term disease course between tissue damage and repair or adaptation.
Aim: To obtain longitudinal measurements of EC and information flows in MS patients at short-term intervals focusing on the main anatomical brain regions and to investigate the link between the connectivity strength and clinical impairment.
Methods: Twelve MS patients (mean age: 41.7 ± 11.5 years) underwent 3 Tesla structural and resting state functional MRI at five different time points over one year (approximately every 12 weeks). Twelve healthy subjects (mean age: 33.5 ± 9.6 years) served as controls (HC). For the analytical framework, two novel approaches for EC quantification were used. Causal Bayesian Network (CBN) and Time Domain Partial Directed Coherence (TPDC) were applied for the description of the information flows between frontal, prefrontal, temporal, occipital, and parietal lobe; cerebellum and deep grey matter nuclei (DGMN) were also analysed.
Results: Specific longitudinal EC patterns have been attested in the studied regions. Information flows from DGMN, frontal, prefrontal and temporal to the other studied regions showed a continuous increase over time, whereas the directed connections from parietal and occipital lobes and from the cerebellum did not change over time as confirmed by both applied methods. No longitudinal changes of EC were attested in HC. The longitudinal connectivity increase in the prefrontal-frontal and fronto-cerebellar pathway showed a significant inverse correlation to EDSS (Expanded Disability Status Scale). Moreover, the EC change from the frontal lobe to the cerebellum showed a significant inverse correlation to patients' fatigue score.
Conclusion: Our data depicts a continuous longitudinal increase in EC in patients with MS substantiated by two novel methodological approaches. Furthermore, the dynamics of the fronto-cerebellar connections are linked to clinical impairment and possibly essential for the long-term outcome.

Disclosure

The authors declare no conflict of interests.