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Continuous short-term structural network reorganisation beyond atrophy in patients with RRMS

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Background and aim: Longitudinal assessment of structural brain changes is important to track the clinical course of multiple sclerosis (MS), but an exact quantification of the diffuse tissue damage is highly challenging. We aimed to identify short-term structural dynamics by measuring grey matter (GM) network connectivity patterns and comparing these with established morphological measures of GM integrity.
Methods: For our prospectively designed study, we collected data from January 2013 through December 2014. In total, forty-five structural MRI datasets from relapsing-remitting MS patients in the relapse free phase of the disease (mean age: 42 ± 12.1 years; median EDSS 1.5 (0 - 2.5); mean disease duration 3.5 ± 6.5 years) were acquired using 3T MRI. Each patient was followed up every 8 weeks for 8 months and all patients were enrolled at two German university hospitals. Longitudinal brain atrophy was analyzed using SIENA (part of FSL), while FreeSurfer was used to investigate cortical thickness changes over time. GM connectivity patterns were reconstructed from cortical thickness correlation matrix between anatomical regions, as derived from the AAL atlas, and a network analysis was conducted using graph theoretical approaches.
Results: Our study shows a significant longitudinal structural network reorganisation in the absence of cortical thinning and brain atrophy already over a period of 4 months. We demonstrate an increased local (clustering coefficient ($F(4,41) = 3.547$, $p < 0.001$), local efficiency ($F(4,41) = 3.0874$, $p < 0.01$)) and modular connectivity pattern (modularity ($F(4,41) = 2.612$, $p < 0.01$)). Conversely a concomitant break-down of long-range connectivity occurred (assortativity ($F(4,41) = 3.0654$, $p < 0.01$) and small-world index ($F(4,41) = 3.687$, $p < 0.001$)). No regional or global atrophy signs were detected in the applied morphometric analysis.
Conclusions and relevance: Our GM network analysis demonstrates a short-term increase in local connectivity and a decrease in long-range paths in MS patients in the relapse free state of the disease, in the absence of atrophy or clinical progression. Structural reorganisation patterns with co-occurrence of detrimental and adaptive reorganisation processes might be important sensitive measurable fingerprints of the disease that can be used in clinical practice.

Disclosure

All listed authors have nothing to disclose.