Disrupted Topological Organization in White Matter Structural Networks in Amnestic Mild Cognitive Impairment: Relationship to Subtype[1]

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Purpose: To investigate the topological alterations of whole-brain white matter structural connectivity in patients with different types of amnestic mild cognitive impairment (aMCI), including single-domain (SD) and multidomain (MD) aMCI, and to explore the relationship of such connectivity with neuropsychologic performance.

Materials and Methods: This study was approved by the institutional review board of Imaging Center for Brain Research, Beijing Normal University. Written informed consent was obtained from each participant. The present study involved 38 patients with aMCI (SD aMCI, $n = 18$; MD aMCI, $n = 20$) and 36 age- and sex-matched healthy control subjects. White-matter connectional architecture in each participant was depicted with diffusion-weighted MR imaging and represented in terms of a connectivity matrix by using a deterministic tractography method. Graph theory–based analyses were then performed to characterize brain network properties.

Results: The global topological organization of white matter networks was significantly disrupted in patients with MD aMCI ($P < .01$ for all) but not in those with SD aMCI, as compared with control subjects. Connectivity impairment in patients with MD aMCI was found in the temporal, frontal, and parietal cortices ($P < .05$, corrected). MD aMCI had decreased network efficiency relative to SD aMCI ($P = .016$), with the most pronounced differences located in the frontal cortex ($P < .01$ for all). Strong associations between cognitive impairments and disrupted topological features (global, $P < .05$; regional, $P < .002$) were identified in patients with aMCI.

Conclusion: The present study suggests early onset disruption of whole-brain white matter connectivity in patients with aMCI, especially in those with the MD subtype, supporting the view that MD aMCI is a more advanced form of disease than is SD aMCI. Moreover, cognitive correlations with topological network properties suggest their potential use as markers to assess the risk of Alzheimer disease.

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