Abnormal whiter matter connectivity network organization in children with autism spectrum disorder using diffusion tensor imaging

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Purpose: In this study, the hypothesis of disrupted whiter matter (WM) connectivity brain networks in children with autism spectrum disorder (c-ASD) is investigated by using diffusion tensor MR imaging.

Methods: Twenty-one c-ASD children (mean age 4.56±0.98 years, 11 males, 10 females) and 21 age and gender matched healthy controls (HC) were included in this study. A 3.0T MR scanner was used and diffusion tensor imaging (DTI) data were acquired. Data postprocessing were performed using FSL and Diffusion Toolkit. WM connectivity was analyzed by using the model with a network comprising a total of 90 cortical and subcortical nodes (AAL template) and 4005 possible edges defined by interregional fiber bundles. After that, the global and local topological patterns were calculated using graph theory analysis through a nonparametric permutation test method.

Results: Global topological patterns: Overall group mean global topological patterns (network strength, global and local efficiency, path length, Cp, Lambda, Gamma and Sigma) were used as a function of the threshold from 1 to 5. Both HC and c-ASD groups showed a small-world organization of WM networks, as expressed by $\sigma > 1$. Compared with HC, decreased characteristic path length (Lp), increased global efficiency and clustering coefficient were observed in c-ASD group. **Nodal characteristics:** Along with the discovery of a disrupted global network organization, inter-group comparison on regional efficiency revealed the alterations in specific brain regions. Compared with HC, the regions with significant difference mainly concentrated in basal ganglia network, including bilateral caudate, putamen, pallidum, and in paralimbic-limbic network, including bilateral hippocampus, parahippocampus gyrus, left temporal pole of superior temporal gyrus and right amygdala. Of note that, most disrupted brain regions in those two networks showed reduced nodal efficiency. Two regions, including left rectus gyrus and right fusiform gyrus, showed significantly increased nodal efficiency in c-ASD group (Fig. 1).

Discussion and conclusion:

In current study, the results of decreased Lp and increased Cp in c-ASD group may result from widely increased WM connectivity in c-ASD, which was consistent with previous study[1]. Functional hyperconnectivity clinical populations is increasingly interpreted as reflecting delayed or stunted maturational processes[2]. Additionally, the regions with significant group effects may reflect developmental derangement. Moreover, brain regions with significant increased efficiency were predominantly located in basal
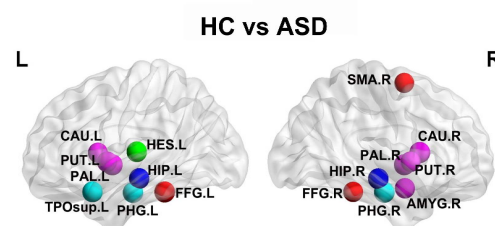

Fig. 1 brain regions with significant difference in nodal efficiency between HC and ASD groups

ganglia network and paralimbic-limbic system, which is consistent with studies [3, 4] highlighting ASD-related dysfunction within motor skills and higher order circuits including social, cognitive and affective process. In short, the current study is for the first time to investigate the topological organization in c-ASD specific to school age children using diffusion tensor imaging. Our results suggested that the topological patterns were disrupted in c-ASD.

References:

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