

Spatial patterns of cortical thinning in neuromyelitis optica: a comparative study with multiple sclerosis

Yaou Liu¹, Teng Xie², Ni Shu², Kuncheng Li¹, and Yong He²

¹Department of Radiology, Xuanwu hospital, Capital Medical University, Beijing, China, ²State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China

Purpose

The aims of the study were to (1) identify spatial patterns of cortical thickness changes in NMO and MS; (2) compare the different patterns of cortical atrophy between NMO and MS; and (3) investigate the correlations between cortical atrophy and clinical variables.

Methods

We studied 23 patients with NMO¹, 27 patients with RRMS² and 27 normal controls. The study was approved by the institutional review board of Xuanwu Hospital, and written informed consent was obtained from each participant. MRI data including T2WI, FLAIR and sagittal three-dimensional (3D) volumetric T1-weighted magnetization-prepared rapid acquisition gradient echo (MPRAGE) with a isotropic voxel size of 1.0 mm were acquired at a 3.0 T MR scanner (Trio Tim Siemens, Germany). Cortical thickness analysis (CTH) was performed by a routine pipeline of the CIVET software (version 1.1.9, Montreal Neurological Institute at McGill University, Montreal, Quebec, Canada). The global mean thickness, regional thickness of the 78 regions of interests from the AAL template, and vertex-based cortical thickness were compared among the three groups by using ANCOVA analysis with age and gender as covariates. To investigate the clinical correlation, we used a general linear model with cortical thickness as dependent variable and clinical score as independent variable. Age and gender effects were removed in this model as covariates.

Results

Global and Regional Cortical Thickness Differences

The ANCOVA showed that the global mean CTh significantly differed among the 3 groups ($p=0.0022$) (Figure 1). The MS group had thinner CTh than the NMO group ($p=0.046$) and the NC group ($p=0.0005$). As to the CTh of AAL regions, the CTh of MS group was thinner than the NMO group in the right insula and the left parahippocampus ($p<0.05$, Bonferroni-corrected). The MS group also showed thinner CTh than the NC group in the opercular part of the left inferior frontal gyrus, bilateral parahippocampus, the left calcarine, bilateral lingual gyrus, the left inferior occipital gyrus, bilateral fusiform, and the right Heschl gyrus ($p<0.05$, Bonferroni corrected). There were no significant differences in regional thickness between the NMO and NC groups.

Vertex-Wise Cortical Thickness Differences

The cortical reduction in NMO group compared to NC group was limited in the left middle occipital gyrus ($p<0.05$, Bonferroni corrected) (Figure 2). By setting the significance level at $p<0.01$ (uncorrected), the NMO subjects also showed thickness reduction in the left superior and middle occipital gyrus, the left inferior frontal and precentral gyrus, the right calcarine and parahippocampus. The MS patients showed more distributed cortical thinning than the NC group mainly in the areas of bilateral parahippocampus, fusiform, calcarine, lingual gyrus, inferior occipital gyrus, superior temporal gyrus, insula, anterior cingulate gyrus, the left superior and inferior frontal gyrus, the left precentral, middle temporal and occipital gyrus, the right supramarginal, Heschl, inferior parietal, medial superior frontal, middle cingulate, paracentral gyrus and the right precuneus (Figure 3). Compared with the NMO group, the MS group showed significant thickness reduction in the left parahippocampus, bilateral insula, and the left inferior occipital gyrus (Figure 4).

Correlation between CTh and Clinical Variables

Expanded Disability Status Scale (EDSS) negatively correlated with CTh in bilateral middle occipital gyri, middle temporal gyri and the right fusiform. The disease duration negatively correlated with CTh in the right calcarine, middle occipital and middle temporal gyri. The Paced Auditory Serial Attention Test-3 (PASAT-3) score positively correlated with CTh in the left superior, middle and inferior frontal gyri and the right inferior temporal gyrus.

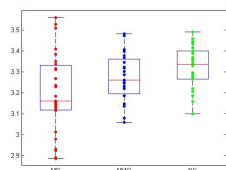


Figure1. Comparison of mean cortical thickness among MS, NMO and NC groups.

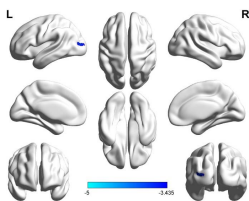


Figure2. Significant cortical thinning in NMO compared with NC ($p<0.05$, corrected)

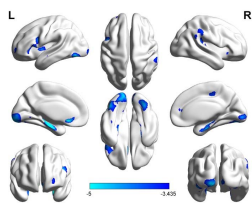


Figure3. Significant cortical thinning in MS compared with NC ($p<0.05$, corrected)

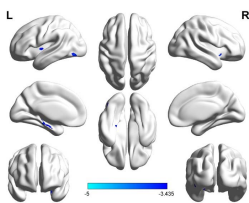


Figure4. Significant cortical thinning in MS compared with NMO ($p<0.05$, corrected)

Conclusion

Mild cortical thinning was identified in NMO, mainly involving visual system. However, MS patients showed widespread cortical thinning, which is distinct from NMO. Specifically, cortical thinning in the medial temporal lobe, insula and inferior occipital gyrus is a key feature to distinguish MS and NMO. Significant correlation between cortical thinning in specific brain areas and clinical variables suggests that cortical thickness measurement could be a sensitive imaging biomarker to monitor clinical severity and disease progression.

References

- 1 Wingerchuk DM, Lennon VA, Pittock SJ, et al. Revised diagnostic criteria for neuromyelitis optica. *Neurology* 2006;66:1485–9.
- 2 Polman CH, Reingold SC, Edan G, et al. Diagnostic criteria for multiple sclerosis: 2005 revisions to the “McDonald Criteria”. *Ann Neurol* 2005;58:840–6