Central sulcus and pericentral cortical changes in multiple sclerosis

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TARGET AUDIENCE: Scientists and physicians who are interested in brain morphologic changes in multiple sclerosis.

PURPOSE: The central sulcus (CS) serves as an important landmark of brain surface and divides motor and sensory cortical areas. State-of-the-art computer-aided image processing techniques together with high resolution three-dimensional MRI, provide great potential for a robust and quantitative estimate of CS changes in vivo. Although cortical atrophy is a key imaging hallmark of multiple sclerosis (MS) and patients with MS often present motor and somatosensory abnormalities, there is limited knowledge about the CS and pericentral cortical gray matter (Pc-CGM) thickness changes in MS. The aim of this study was to investigate differences in central sulcal volume, width and depth as well as Pc-CGM in patients with MS as compared to healthy controls.

METHODS: Forty-three clinically confirmed MS patients and 52 healthy control subjects matched for age and gender were recruited in this study. Images were generated based on a standard high resolution T1-weighted magnetization-prepared rapid gradient echo (MPRAGE) sequence on a 3T scanner. Image analysis was performed with the Morphologist toolbox using BrainVISA 4.4 software (http://brainvisa.info/) and included intensity homogeneity correction, gray and white matter segmentation, removal of non-brain tissue and cerebellum, splitting of the hemispheres and skeletonization of the GM-CSF interface. These skeletonized regions were transformed into surfaces and subsequently into cortical folds graphs, which were automatically labeled and checked for accuracy.[1] The left and right central sulci were selected for further processing. Figure 1 shows several quantitative CS and Pc-CGM thickness measures generated using the morphometry statistics tool in BrainVISA. These measurements were compared between patients and controls using two sample t-tests in SPSS 21. Pearson's correlation analyses were performed between CS volume and width and Pc-CGM thickness and between these imaging measures and Expanded Disability Status Scale (EDSS) scores in 31 MS patients.

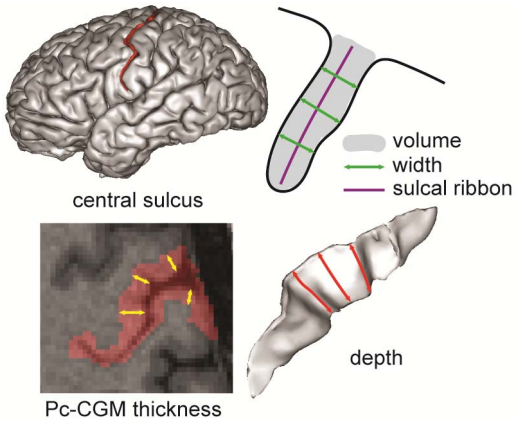

Figure 1. Explanation of different measures used in this study. Pc-CGM thickness was calculated as the mean of the thickness of the cortical sheet in the central sulcus region. Depth was calculated as the mean geodesic depth along the sulcus. Volume was calculated as the number of voxels in the sulcal area, multiplied by the voxel volume. Mean width was calculated by dividing the volume of the sulcus by the surface of the sulcal ribbon

RESULTS: There were significant differences in sulcal width, volume and Pc-CGM thickness (see Figure 2). Both the left and right central sulcus had decreased Pc-CGM thickness and increased CS volume in MS patients. Width was significantly increased, but only in the left hemisphere. GM thickness correlated significantly with both volume (left: r=-.521, p=.003; right: r=-.557, p=.001) and width (left: r=-.553, p=.001; right: r=-.610, p<0.001). EDSS scores correlated significantly in with volume (r^2=.223, p=.007) and Pc-CGM thickness (r^2=.139 p=.04) in the right central sulcus.

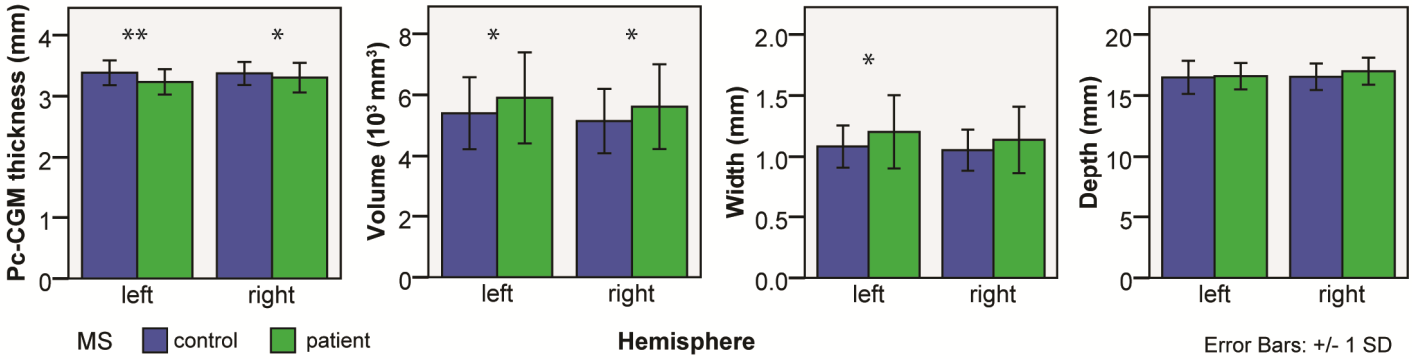

Figure 2. Comparison between patients and controls. Bar graphs showing mean values of different measures. Significant differences are flagged: **p<0.001, *p<0.05

CONCLUSION: CS showed significant morphological and topological changes in MS patients, in particular the sulcal volume and width. Since CS metrics are correlated with clinical disability measure, there is potential to use them as quantitative markers of progression. The sulcal changes also correlated with local atrophy measure of Pc-CGM thickness in patients. These data suggest that CS and pericentral regions are affected and detectable in MS, and these changes may be responsible for their clinical motor and sensory symptoms. Longitudinal analysis to better understand its potential role is warranted.

REFERENCES: 1: Mangin JF, Rivière D, Cachia A, et al. A framework to study the cortical folding patterns. NeuroImage. 2004; 23: S129–S138.

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