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Evidence of Neural Microstructure Abnormalities in Type I Chiari Malformation: Associations Among Fiber Tract Integrity, Pain, and Cognitive Dysfunction

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Purpose

Previous case–control investigations of type I Chiari malformation (CMI) have reported cognitive deficits and microstructural white matter abnormalities as measured by diffusion tensor imaging (DTI). CMI is also typically associated with pain, including occipital headache, but the relationship between pain symptoms and microstructure is not known.

Methods

Eighteen female CMI patients and 18 adult age- and education-matched control participants underwent DTI, were tested using digit symbol coding and digit span tasks, and completed a self-report measure of chronic pain. Tissue microstructure indices, fractional anisotropy (FA), radial diffusivity (RD), and mean diffusivity (MD), were used to examine brain microstructural abnormalities in CMI as compared with healthy controls. Group differences in DTI parameters were then reassessed after controlling for self-reported pain. Finally, DTI parameters were correlated with performance on the digit symbol coding and digit span tasks within each group.

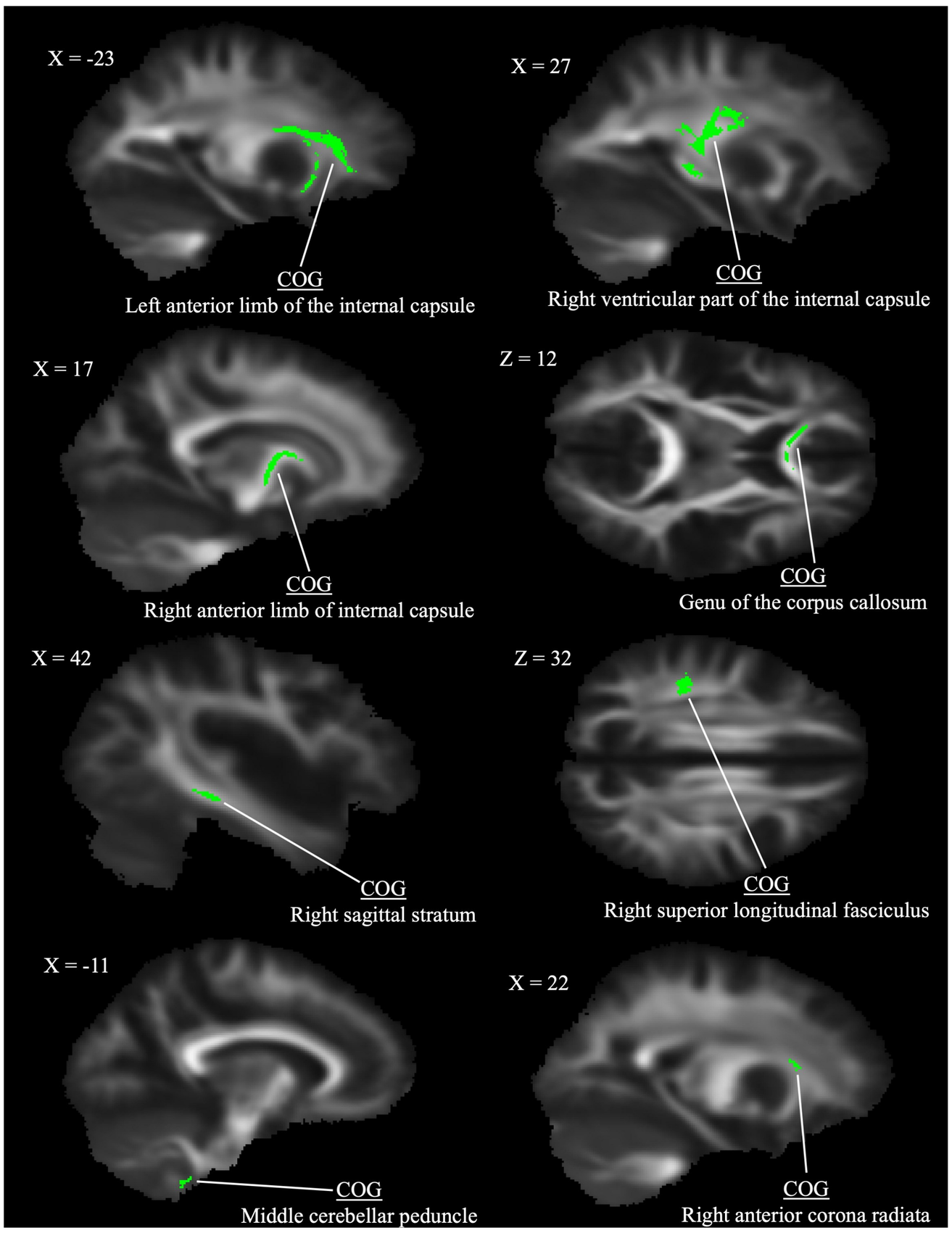
Results

CMI patients exhibited greater FA, lower RD, and lower MD in multiple brain regions compared with controls in diffuse white matter regions. Group differences no longer existed after controlling for self-reported pain. A significant correlation between FA and the Repeatable Battery for the Assessment of Neuropsychological Status coding performance was observed for controls but not for the CMI group.

Conclusions

Diffuse microstructural abnormalities appear to be a feature of CMI, manifesting predominantly as greater FA and less diffusivity on DTI sequences. These white matter changes are associated with the subjective pain experience of CMI patients and may reflect reactivity to neuroinflammatory responses.

Clusters of significantly greater fractional anisotropy (FA) in type I Chiari malformation patients



Labels are derived from the Johns Hopkins University white matter atlas. COG—Center of Gravity, the geometric center of a brain area of significant microstructural difference between CMI patients and healthy control participants.