

Probing Brain Magnetic Susceptibility Alterations in a Mouse Model of Multiple Sclerosis

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Multiple sclerosis (MS) is an increasing cause of disability in the United States, characterized by autoimmune demyelinating events in the central nervous system. MS patients can present with a varying range of symptoms and disability due to the chronic inflammatory and relapsing events associated with the disease, such as impaired mobility, slowed cognitive processing, and high probability of disease progression.

MS can be morphologically characterized by the damage to the myelin sheath that surrounds axons, oligodendrocytes that produce myelin, and axons that transmit information to different neurons. Due to the complicated mechanism of MS, the advanced MRI methods which can provide both sensitive and specific assessment of MS tissue injury hold the promise to provide critical mechanistic guidance of MS and serve as robust imaging biomarkers for MS. Several animal models have been established to understand the distinct aspects of the disease. Cuprizone, a copper chelator, creates demyelination events comparable to MS, allowing the mouse model to be a representation of MS. QSM's ability to accurately distinguish between and predict acute and chronic demyelination events. Recently, we have demonstrated that the novel quantitative susceptibility mapping (QSM) can identify between the demyelination and remyelination process in the corpus callosum of mice treated with cuprizone. However, how early QSM can detect brain alterations has not been investigated.

We acquired high-resolution in vivo whole-brain QSM, T2-weighted, and magnetization transfer ratio (MTR) images at 0, 2, and 4 weeks after cuprizone administration. The corpus callosum exhibited significant changes in T2-weighted and MTR images at 4 weeks after cuprizone administration. In contrast, QSM decreased significantly in QSM at 2 weeks after cuprizone administration. Since dramatic demyelination only starts after oligodendrocytes depletion (3 weeks after cuprizone treatment), QSM may be able to detect the alteration of oligodendrocytes and serve as a sensitive biomarker even before demyelination occurs.