Diffusion tensor imaging of multiple sclerosis models

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Multiple sclerosis (MS) is an inflammatory demyelinating disease of central nervous system (CNS) that inflicts debilitating neurological disability in young adults. Despite extensive research efforts, the pathogenesis of MS is still not fully understood. The hallmark of MS lesions is the presence of inflammatory infiltrates and demyelination in the CNS white matter. Axonal damage has also been implicated as a prominent feature of MS, as transected axons have been seen in both active and chronic demyelinated lesions. The demyelinating lesions in MS have been the focus of research for the decade. The discovery of considerable axonal damage has led to a paradigm shift in MS research with increasing attention on the underlying axonal damage in MS and its clinical implication.

Animal models are widely used to gain a better understanding of the underlying pathophysiology of MS lesions. Commonly employed rodent models of MS include the experimental autoimmune encephalomyelitis (EAE), the viral-induced models of Theiler's murine encephalitis virus (TMEV) infection, and the toxin-induced models of the cuprizone or lysolecithin administration. Despite the existing controversy, EAE has contributed a great deal in our understanding of this disease as well as the development of several anti-inflammatory drugs treating MS currently in use. The cuprizone induced demyelination and remyelination of mouse corpus callosum has recently seen an increased frequency of use in MR research community.

In this brief discussion on diffusion tensor imaging (DTI) of MS models, our experience examining mouse models of both cuprizone induced demyelination-remyelination and EAE using in vivo DTI will be described in details. Although EAE is not MS, it does present pathologies seen in MS such as inflammation, demyelination, and axonal injury. The primary goal of animal studies is to establish the correlation between the histopathology of white matter and the DTI signal changes. Quantitative validation of DTI findings will be presented with neurological correlations in EAE mice. Although it is believed that axonal damage is the cause of long-term impairment in MS, current serum markers have not been able to adequately determine the extent of axonal damage. The noninvasive imaging techniques such as DTI have the potential to play a crucial role of providing the long sought biomarker of axonal injury in MS.

References


