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The Utilization of Manganese-Enhanced Magnetic Resonance Imaging in the Fields of Ophthalmology and Visual Neuroscience

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Abstract : Understanding how vision works in both health and disease involves understanding the anatomy and physiology of the eye as well as the neural pathways involved in visual perception. The development of imaging techniques for the visual system is essential for understanding the neural foundation of visual function or impairment. MRI provides a way to examine neural circuit structure and function without invasive procedures, allowing for the detection of brain tissue abnormalities in real time. One of the advanced MRI methods is manganese-enhanced MRI (MEMRI), which utilizes active manganese contrast agents to enhance brain tissue signals in T1-weighted imaging, showcasing connectivity and activity levels. The way manganese ions build up in the eye, and visual pathways can be due to their spread throughout the body or by moving locally along axons in a forward direction and entering neurons through calcium channels that are voltage-gated. The paramagnetic manganese contrast is utilized in MRI for various applications in the visual system, such as imaging neurodevelopment and evaluating neurodegeneration, neuroplasticity, neuroprotection, and neuroregeneration. In this assessment, we outline four key areas of scientific research where MEMRI can play a crucial role - understanding brain structure, mapping nerve pathways, monitoring nerve cell function, and distinguishing between different types of glial cell activity. We discuss various studies that have utilized MEMRI to investigate the visual system, including delivery methods, spatiotemporal features, and biophysical analysis. Based on this literature, we have pinpointed key issues in the field related to toxicity, as well as sensitivity and specificity of manganese enhancement. We will also examine the drawbacks and other options to MEMRI that could offer new possibilities for future exploration.

Keywords : glial activity, manganese-enhanced magnetic resonance imaging, neuroarchitecture, neuronal activity, neuronal tract tracing, visual pathway, eye
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