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## Diffusion Tensor Imaging and Its Application to Traumatic Brain Injury: Basic Principles and Recent Advances

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### ABSTRACT

Traumatic axonal injury is a progressive process evoked by shear forces on the brain, gradually evolving from focal axonal alteration and cumulating in neural disconnection. Clinical classifiers and conventional neuroimaging are limited in traumatic axonal injury detection, outcome prediction, and treatment guidance. Diffusion weighted imaging is an advanced magnetic resonance imaging (MRI) technique that is sensitive to the movement of water molecules, providing additional information on the micro-structural arrangement of tissue. Quantitative analysis of diffusion metrics can aid in the localization of axonal injury and/or de(dys) myelination caused by trauma. Diffusion MRI tractography is an extension of diffusion weighted imaging, and can provide additional information about white matter pathways and the integrity of brain neural networks. Both techniques are able to detect the early micro-structural changes caused by Traumatic Brain Injury (TBI), and can be used to increase understanding of the mechanisms of brain plasticity in recovery after brain injury and possibly optimize treatment planning of patients with Traumatic Brain Injury. This review focuses on the theoretical basis and applied advanced techniques of diffusion weighted imaging, their limitations and applications, and future directions in the application to TBI.

### KEYWORDS

Brain Network; Connectivity; High Angular Resolution Diffusion Imaging (HARDI); Diffusion Tensor Imaging (DTI); Neurocircuitry; Neuroimaging; Traumatic Axonal Injury (TAI); Traumatic Brain Injury (TBI); Tractography; White Matter

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