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White matter integrity and cognition in chronic traumatic brain injury: a diffusion tensor imaging study.

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Abstract

Traumatic brain injury (TBI) is a serious public health problem. Even injuries classified as mild, the most common, can result in persistent neurobehavioural impairment. Diffuse axonal injury is a common finding after TBI, and is presumed to contribute to outcomes, but may not always be apparent using standard neuroimaging. Diffusion tensor imaging (DTI) is a more recent method of assessing axonal integrity in vivo. The primary objective of the current investigation was to characterize white matter integrity utilizing DTI across the spectrum of chronic TBI of all severities. A secondary objective was to examine the relationship between white matter integrity and cognition. Twenty mild, 17 moderate to severe TBI and 18 controls underwent DTI and neuropsychological testing. Fractional anisotropy, axial diffusivity and radial diffusivity were calculated from the DTI data. Fractional anisotropy was the primary measure of white matter integrity. Region of interest analysis included anterior and posterior corona radiata, cortico-spinal tracts, cingulum fibre bundles, external capsule, forceps minor and major, genu, body and splenium of the corpus callosum, inferior fronto-occipital fasciculus, superior longitudinal fasciculus and sagittal stratum. Cognitive domain scores were calculated from executive, attention and memory testing. Decreased fractional anisotropy was found in all 13 regions of interest for the moderate to severe TBI group, but only in the cortico-spinal tract, sagittal stratum and superior longitudinal fasciculus for the mild TBI group. White Matter Load (a measure of the total number of regions with reduced FA) was negatively correlated with all cognitive domains. Analysis of radial and axial diffusivity values suggested that all severities of TBI can result in a degree of axonal damage, while irreversible myelin damage was only apparent for moderate to severe TBI. The present data emphasize that white matter changes exist on a spectrum, including mild TBI. An index of global white matter neuropathology (White Matter Load) was related to cognitive function, such that greater

white matter pathology predicted greater cognitive deficits. Mechanistically, mild TBI white matter changes may be primarily due to axonal damage as opposed to myelin damage. The more severe injuries impact both. DTI provides an objective means for determining the relationship of cognitive deficits to TBI, even in cases where the injury was sustained years prior to the evaluation.

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