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A COMPUTATIONAL MODEL COUPLING MECHANICS AND ELECTROPHYSIOLOGY IN SPINAL CORD INJURY

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Despite many recent experimental and modelling campaigns focused on the mechanics of tissue and cell damage in traumatic brain and spinal cord injuries, the relative roles of strain and strain rate, on the one hand, and stress and stress rate, on the other hand remain unclear. More specifically, a direct link between brain and spinal cord structural damage, and electrophysiological functional impairment is still largely missing. Indeed, mechanical modelling efforts have mainly focused on stress distribution and mechanistic-based damage criteria, and fully multiscale function-based damage criteria have so far not been proposed. To this end, a new multiscale model of myelinated axon providing a link between electrophysiological impairment and structural damage, function of macroscopic strain and strain rate, is proposed here. Each axon is model eventually included in a statistical model aimed at providing an overall white matter behavior. This multiscale approach provides a new framework for damage evaluation directly relating neuron mechanics and electrophysiological properties, thus providing a link between mechanical trauma and subsequent functional deficits. It also provides important insights on the representativeness of one unique axon within the white matter.