Understanding the mechanisms of atrophy associated with spinal cord injury: the application of MRI-based in vivo histology and ex vivo histology, (hMRIofSCI)

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Spinal cord injuries (SCI) are mainly caused by traumatic events, such as traffic and sports accidents and violence. Paraplegia (legs paralysed) and tetraplegia (both legs and arms paralysed) permanently, severely and dramatically reduce the quality of life of the affected person as well as their ability to remain a member of the workforce. These negative consequences arise because functional recovery following SCI remains limited and the majority of patients are left with severe impairments in the longer term. While rehabilitative training can improve clinical outcome following SCI, which is a major benefit to the patients' quality of life, the degenerative processes as well as the mechanisms underpinning any neurological and functional recovery are not well understood. Recent advances in the field of magnetic resonance imaging (MRI) have vastly improved how we can visualize and interrogate the structural organisation and functioning of the central nervous system. Notable among these advances is the emerging ability to investigate “microscopic” changes in the human central nervous system. This includes distinguishing white and grey matter – two fundamental divisions of structure in the spinal cord, brainstem, and brain. Using microscopic MRI protocols we have shown that structural changes occur over time following a specific spatial and temporal pattern. In fact these changes occur early after the injury and happen both in the cord and in the brain. However so far, the range of biological changes that may underlie the observed changes cannot be disentangled. By means of in vivo histology using MRI (hMRI) - an emerging field in MRI - we aim to establish the missing link between measured MRI signals and changes in the underlying tissue microstructure, which will help us to explain and better understand the disease processes associated with spinal cord injury.