Average Axon Diameter Mapping of Pig Spinal Cord Using d-PFG Filtered MRI

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The diameter of myelinated axons is a critical neurophysiological parameter that helps correlate with conduction velocity. In the spinal cord, axons are somatotopically organized into distinct anatomical regions performing specific functions, and characterized by different diameters and diameter distributions. In this study the use of double pulsed-field gradient (d-PFG) MRI to measure and map the apparent mean diameters within different regions of the spinal cord white matter was evaluated. In order to do so, double-PFG MRI images were acquired on a formalin-fixed pig spinal cord and a recently introduced theoretical framework was used to fit the data. A pixel-by-pixel analysis was applied to create a fiber diameter map within the white matter region of the spinal cord. K-means segmentation was performed using information obtained from the d-PFG filtered MRI experiments. The MRI data were compared with histological data.

The fiber diameter estimates ranged between 3 and 5 μm, which is in the expected range for such specimens. The distinct clusters produced from data showed similar trends to the histological staining. This indicates that d-PFG filtered MRI is a powerful tool for mapping axon diameter and potentially other microstructural tissues features.

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