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A fully integrated imaging protocol and post-processing pipeline for tract-specific quantitative cervical spinal cord MRI in degenerative cervical myelopathy

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Background: Degenerative Cervical Myelopathy (DCM) is the primary cause of adult spinal cord dysfunction, diagnosed by a combination of clinical myelopathy with spinal cord compression on MRI. However, structural MRI provides limited insight into quantifying spinal cord injury, complicating the prediction of clinical progression and postoperative recovery. Recent DCM research highlights the need for quantitative MRI sequences, with Diffusion Weighted Imaging (DWI) and T2*-weighted sequences as promising candidates. However, their practical use is hindered by poor sensitivity, motion artifacts, and complex post-processing.

Research question: To establish a reliable acquisition protocol and a comprehensive post-processing program leading to a clinically usable MRI tool.

Design: This study is part of a prospective pilot study in 5 healthy volunteers and 10 DCM patients, designed to improve diagnostic workup for DCM patient.

Methods: First, we generated an imaging protocol for T1, T2, T2*, and DWI sequences by adapting existing hospital and generic protocols. After this, we developed a post-processing pipeline using 2 open-source software tools.

Results: Healthy volunteers were scanned, adjusting the protocol every 1 or 2 scans to achieve sufficient resolution within a 30-minute timeframe. Subsequently, the protocol was fine-tuned with study patients to minimize motion artifacts, creating an imaging protocol meeting criteria for quality and efficiency. The pipeline was refined to denoise, correct motion and segment consecutively. Tracts are localized by overlaying an atlas and measurements extracted. Each step was carefully adjusted for robustness to low image quality. The pipeline, integrated into a Python program, is tailored for clinical use.

Discussion: We developed a reliable acquisition protocol and comprehensive post-processing integrating DWI and T2* sequences for routine use in DCM patients.