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The First Clinical Use of Quantitative Spinal Cord MRI: Serial Monitoring to Identify Disease Progression in Patients with Degenerative Cervical Myelopathy Managed Non-Operatively

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Objectives

The natural history of degenerative cervical myelopathy (DCM) is variable, ranging from long-term clinical stability to rapid decline. Clinical progression may be masked by neuroplasticity, behavioural adaptation, and the subjective and transient nature of symptoms such as fine motor dysfunction, numbness, and gait impairment. Quantitative MRI (qMRI) techniques can directly measure tissue injury in terms of axonal loss, demyelination, and atrophy. This longitudinal prospective study assesses the utility of serial qMRI at 1-year follow-up to detect disease progression in DCM patients managed non-operatively.

Method

12 DCM patients with 1-year follow-up data were included. Clinical data included mJOA, Nurick, QuickDASH, CSM-GRASSP, grip strength, monofilament sensation, Berg Balance, and GaitRITE. 3T MRI data included SC cross sectional area (CSA), diffusion fractional anisotropy (FA), magnetization transfer ratio (MTR), and T2*-weighted white to grey matter signal intensity ratio (T2*w WM/GM), extracted from maximally compressed level (MCL) and rostral (C1-C3) and caudal (C6-C7) levels. Disease progression was defined clinically by a 1-point decrease in mJOA or 3 other measures worsening by 5%. qMRI progression was defined as any of 10 univariate measures or a composite score worsening by 2.65 standard deviations of previously established test-retest variability ($p=0.004$, single-tailed, corrected for multiple comparisons).

Results

4 of 14 patients (28.6%) showed clinical worsening at 1 year, including 2 patients with a decline in mJOA and 2 patients with decreases in other scores (grip strength, sensation, gait). 6 of 14 patients showed qMRI progression, including all 4 subjects with clinical progression. qMRI progression was most commonly seen with changes in MCL CSA (4 subjects) and MCL T2*w WM/GM ratio (3 subjects).

Conclusions

Quantitative multi-parametric SC MRI appears to detect progression of SC tissue injury with greater sensitivity than clinical assessments, including mJOA score. These follow-up results have been made available to the treating surgeons, for consideration during surgical decision-making. To our knowledge, this represents the first clinical use of SC qMRI and an important step toward clinical translation of these techniques.



NOTE: *Allan Martin was the recipient of the award for the 2017 Best Resident's Paper at the 2017 Annual Scientific Conference of the Canadian Spine Society for this abstract presentation.*