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Differentiating Axonal from Demyelinating Neuropathies using Multiparametric Quantitative MRI of Peripheral Nerves

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Objectives: To develop a multiparametric quantitative MRI (qMRI) method to track pathological changes in the peripheral neuropathies.

Background: Irrespective of the causes or types of polyneuropathies, peripheral nerves are mainly afflicted by two kinds of pathologies – axonal loss and demyelination. It is critical to differentiate between the two as treatments are different for the two conditions. While nerve conduction studies (NCS) have been used to differentiate the two pathologies in the distal nerves, there are no tools to probe the pathologies in the proximal peripheral nerves. This is particularly needed when distal nerves become non-responsive in NCS.

Methods: We have developed a qMRI method that quantifies the sciatic and tibial nerves with 10 parameters that are sensitive to different aspects of myelin and axonal pathologies: magnetization transfer ratio (MTR), magnetization transfer saturation index (MTsat), longitudinal relaxation time (T1), proton density (PD), effective transverse relaxation time (T2*), fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD), radial diffusivity (RD), and nerve fascicular volume (fVol). In this pilot study, we studied 4 patients with Charcot-Marie-Tooth type-1A (CMT1A), 2 patients with CMT type-2S (CMT2S), and 17 healthy controls.

Results: Compared with the healthy controls, patients with CMT2S (axonal type) had a comparable MTR, MTsat, T1, PD and fVol, but a reduced T2*. While patients with CMT1A (demyelinating type) had a reduced MTR and MTsat, increased fVol, T1 and PD, and comparable T2*. All 6 patients with CMT shared a change in reduced FA, which was driven by a reduced AD and an increased RD.

Conclusions: The data show different qMRI patterns between axonal and demyelinating neuropathies. The differential changes will be further verified in a larger cohort of patients with peripheral neuropathies.