Abstract Title: Lesion Classification in Multiple Sclerosis Using Texture-Derived Super-Voxels

Abstract Short Title: Super-Voxel Characterization of MS Lesions

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QS, DI and AC are employees of Therapanacea.

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Introduction:

Multiple sclerosis (MS) lesions, which are detectable as white matter hyperintensities (WMHs) on T2-weighted (T2-w) MRI, can form large conglomerates as they accumulate over time. In these conglomerates, lesions can be difficult to isolate into discrete lesion types.

Objectives:

To develop an algorithm to parcellate WMHs into super-voxel sub-regions, grouping texturally consistent voxels in terms of spatial proximity and signal intensities.

Methods:

Brain T1-w and T2-w MRIs from the ADVANCE (NCT01416181; n = 1,512, with relapsing-remitting MS [RRMS]), ASCEND (NCT01416181; n = 886, with secondary progressive MS), DECIDE (NCT01064401; n = 1841, with RRMS,) and EXTEND (NCT01797965; extension from DECIDE, n = 1,501) trials were retrospectively analysed. In each T2-w scan, WMHs were delineated via a semi-automatic method and were segmented into acute and chronic MS lesion masks, based on the presence of gadolinium enhancement or concurrence with new or enlarging T2 lesions. The mean-shift algorithm was applied to each WMH, using Gaussian

kernels of standard deviations 1.5 and 0.3, and Euclidean and Mahalanobis distances for the spatial and intensity domains, respectively. In each super-voxel, the volumetric proportion of acute versus chronic MS lesion activity was measured to evaluate homogeneity of resulting super-voxels.

Results:

Patients' WMHs were parcellated into 500 super-voxels, with an average size of 17.1 mm, a median at 7.2 mm, and a first and third quartile at 2.5 mm^3 and 19.8 mm^3, respectively. Each super-voxel generally contained strong volumetric dominance of one lesion class (e.g., acute or chronic) over the other.

Conclusions:

Super-voxels were dominantly partitioned within a specific lesion type. This suggests that mean-shift could be used as a pre-processing step enabling voxel-level classification of MS lesion types from a super-voxel level processing, allowing for faster predictions and improved accuracy of MS lesion classification, resulting from the expected reduction in label noise.

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