Abstract Title: Clustering Multiple Sclerosis Lesions by Spatial, Geometric and Textural Domains

Abstract Short Title: Unsupervised Lesion Clustering in MS

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Author Disclosures:

BC, AG, XJ, DPB, EF, and SB are employees of and hold stock/stock options in Biogen.

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Introduction:

Multiple sclerosis (MS) lesions exhibit substantial pathophysiological heterogeneity, which may be observable macroscopically as geometric and/or textural patterns within MS lesions using MRI. Unsupervised clustering approaches leveraging radiomic features identify MS lesions that are pathologically distinct and offer clinical value for prognosis and/or predicting treatment response.

Objectives:

To identify populations of focal acute MS lesions using machine learning approaches and radiomic features that exhibit consistent positional, textural and/or geometric patterns, as observed on conventional, non-contrast, cross-sectional T1- and T2-weighted brain MRI.

Methods:

Brain T1- and T2-weighted MRIs from the ADVANCE (NCT00906399; n=1,512, with relapsing-remitting MS) and ASCEND (NCT01416181; n=886, with secondary progressive MS) trials were retrospectively analysed. In total, 7481 focal acute (T1 gadolinium-enhancing and/or new or

enlarging) white matter T2 lesions were identified. Each lesion was represented via its center of mass, shape properties and texture properties, as measured via radiomics. Similar lesions were grouped together by an unsupervised clustering algorithm based on LP-stability and applied separately across the spatial, textural, and shape domains. The optimal combination of a similarity metric and a sub-populations count was identified and optimized for a cluster quality metric, defined as a weighted average of the silhouette score and Davies-Bouldin index.

Results:

We observed optimal clustering quality when we stratified acute lesion samples into 9 prototypical spatial locations in the supratentorial white matter, 14 prototypical textures and 3 prototypical shapes. In each domain, the proportion of lesions assigned to each cluster was evenly balanced.

Conclusions:

Clusters of acute MS lesions were identified with specific spatial, geometric, and textural patterns, the clinical relevance of which will be further characterized against clinico-radiological endpoints of disease progression. Future efforts will target clustering analysis of multi-focal chronic lesion conglomerates, discovering heterogeneity patterns associated with chronic active inflammatory and neurodegenerative pathology.

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