Tracking the Evolution of Cerebral Gadolinium-enhancing Lesions to Persistent T1 Black Holes in Multiple Sclerosis: Validation of a Semiautomated Pipeline

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BACKGROUND: Some gadolinium-enhancing multiple sclerosis (MS) lesions remain T1-hypointense over months (”persistent black holes, BHs”) and represent areas of pronounced tissue loss. A reduced conversion of enhancing lesions to persistent BHs could suggest a favorable effect of a medication on tissue repair. However, the individual tracking of enhancing lesions can be very time-consuming in large clinical trials. PURPOSE: We created a semiautomated workflow for tracking the evolution of individual MS lesions, to calculate the proportion of enhancing lesions becoming persistent BHs at follow-up. METHODS: Our workflow automatically coregisters, compares, and detects overlaps between lesion masks at different time points. We tested the algorithm in a data set of Magnetic Resonance images (1.5 and 3T; spin-echo T1-sequences) from a phase 3 clinical trial (n = 1,272), in which all enhancing lesions and all BHs had been previously segmented at baseline and year 2. The algorithm analyzed the segmentation masks in a longitudinal fashion to determine which enhancing lesions at baseline turned into BHs at year 2. Images of 50 patients (192 enhancing lesions) were also reviewed by an experienced MRI rater, blinded to the algorithm results. RESULTS: In this MRI data set, there were no cases that could not be processed by the algorithm. At year 2, 417 lesions were classified as persistent BHs (417/1,613 = 25.9%). The agreement between the rater and the algorithm was > 98%. CONCLUSIONS: Due to the semiautomated procedure, this algorithm can be of great value in the analysis of large clinical trials, when a rater-based analysis would be time-consuming.
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