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Detection of new multiple sclerosis lesions on longitudinal brain MRI

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Background: Determining the presence/absence of new T2 lesions is an accepted biomarker and a key factor to evaluate treatment efficacy in MS. However, this is commonly done visually or semi-automatically being time-consuming and prone to observer errors.

Objective: To compare a set of recent automated methods to detect new T2 MS lesions on serial brain (baseline and one-year follow-up) MRI scans of patients presenting a clinically isolated syndrome (CIS).

Materials and methods: The cohort included 60 patients that were scanned with a 3T magnet, including transverse T2-FLAIR, PD-w, T2-w and T1-w images. 37 of these patients (61.7%) presented new T2 lesions that were visually and semi-automatically annotated by expert neuroradiologists (using the Jim tool). The mean number of new T2 lesions was 6.17 (SD=9.9) and the mean new T2 lesion volume was 203.18 (SD=404.5) mm3. The performance of three different methods was compared with respect to the experts' annotations. The first one, being an automated pipeline based on subtraction and deformation fields computed using Demons non-rigid registration, while the second and third pipelines were based on the LST toolbox for SPM, which incorporates two different approaches to segment lesions in a given time point (LGA and LPA) and a strategy to compare the segmentations between time points of these approaches to provide a longitudinal analysis for each.

Results: The first pipeline obtained a 71.8% true positive fraction (TPF) in terms of detection and a 63.3% TPF in terms of segmentation. Using the LGA and LPA methods, these values decreased to 45.2% and 28.7% for detection and to 35.7% and 16.0% for segmentation. Regarding false positive fraction, the first method obtained values of 20.4% and 33.3% for detection and segmentation respectively compared to 37.7% and 54.5% for the LGA and 70.3% and 86.01% for the LPA method. The Dice similarity coefficient and the average surface distance were also better with the first approach. Regarding the patients without new lesions, the first method found false positives in 21.7% of the cases compared to 43.5% and 91.3% for the LGA and LPA respectively.

Conclusion: The automated method based on subtraction and deformation fields outperformed the pipelines implemented on the LST toolbox for the given cohort. These results show that subtraction approaches are preferred for automated lesion detection than approaches based on comparing independent segmentations for each time point.

Disclosure

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