Background: One of the common strategies for detecting evolving MS lesions in serial brain MRI is the point-to-point subtraction between two successive scans. However, the methods based on this strategy suffer from repositioning errors due to patient movement, image artifacts, and partial volume effects. Thus, they are challenging methods which require robust steps for providing useful and reliable subtracted images.
Aim: To analyze and evaluate a subtraction approach used for detecting evolving white matter MS lesions in serial brain MRI scans.
Methods: We analyzed in detail all the steps required for a subtraction pipeline: skull stripping, bias field correction, histogram matching, rigid body registration, point-to-point subtraction, white matter masking, intensity thresholding and removal of small spots. The intracranial cavity (ICC) is identified for each time point using the BET extraction tool, while the soft tissues of the MRI scans are also automatically obtained. In the second step, bias field correction is applied to the ICC masked MR images at all time points. Afterwards, the gray scale values between two-time points are normalized by using a histogram matching technique. Thereafter, the outcome normalized MR images are aligned by a rigid half-way registration which reduces the errors due to interpolation. Finally, the images are subtracted and then thresholded with respect to the intensity values on the union of white matter masks.
Results: The experiments were performed using real data sets (PD-w and T2-w FLAIR images) on 1.5T, and the corresponding ground truth annotations provided by expert radiologists (full lesion annotation on the baseline and new appearing lesions in the 12-month control). In total, 42 new WM lesions were correctly identified by our pipeline among 67 lesions detected by experts (63% of success). The results of the subtraction approach as well as the impact of the pipeline steps were quantitatively evaluated using several voxel-based and region-based measures, providing insight in different aspects of the detection of evolving MS lesions.
Conclusion: We have obtained promising MS lesion change detection results, analyzing also the importance of each of the proposed pipeline steps. We have seen how the necessity of fixing an intensity threshold is still an open issue while the false-positive and false-negative voxel detections have to be improved in order to have a fully automatic approach ready for the clinical practice.

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