IMPROVED PROBABILISTIC SEGMENTATION OF WHITE MATTER LESIONS IN MULTIPLE SCLEROSIS

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INTRODUCTION

Multiple sclerosis is a disorder of the central nervous system primarily characterized by inflammatory white matter lesions (plaques) that can be detected by MRI. Segmentation of different cerebral tissue classes is an important step in image processing. Automated segmentation procedure implemented in SPM software[1] uses the differences in intensity values of the patient's image(s) and a priori « tissue probability maps » (TPM). The standard TPM are derived from a population of young and healthy subjects. In the presence of focal lesions, this can lead to significant inappropriate image segmentation.

OBJECTIVES

We propose a modified procedure to segment and normalize brain MR images in the presence of demyelinated lesions and extract a posteriori probability maps of lesions.

METHODS

1. We semi-automatically generate a binary lesion mask from FLAIR images[2] .
2. Using this binary lesion mask, we add a patient specific lesion tissue probability map to the standard TPM (i.e. white and grey matter, cerebrospinal fluid, skull…) and the white matter a priori map is updated accordingly[3].
3. We apply "unified segmentation" (SPM12) with these updated TPM on FLAIR and magnetization transfer (MT) MR images[4] (fig.1).

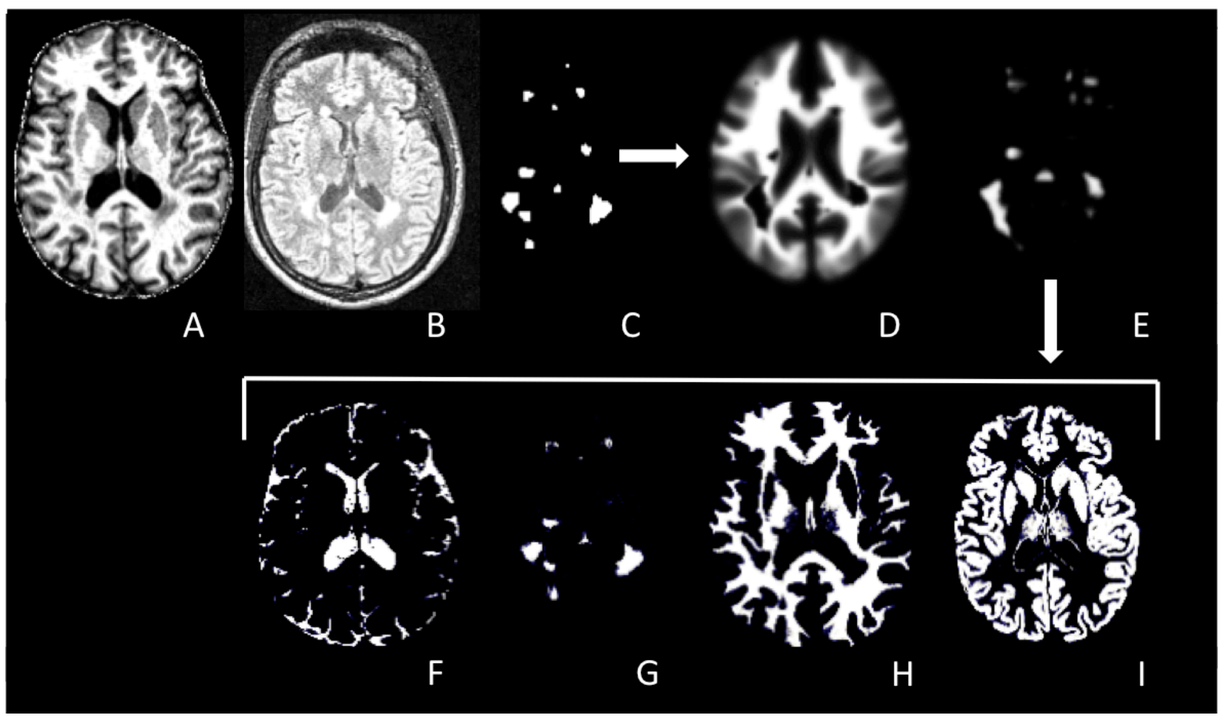

Figure 1. (A) MT MR imaging; (B) FLAIR 3D; (C) binary lesion mask; (D, E) updated WM and lesion TPM's; (F-I) a posteriori probability maps (CSF, lesion, white & gray matter) resulting of unified segmentation of MR images.

RESULTS

We have successfully applied this method on 5 different datasets, with various lesion loads and brain atrophy degrees. We obtain an a posteriori probability map of tissue classes, including lesions and normal appearing white matter. Compared to the original lesion mask, this procedure allows a more refined segmentation of lesions together with a correct normalization into standard template space (Montreal Neurological Institute) for further group level analysis (fig.2).

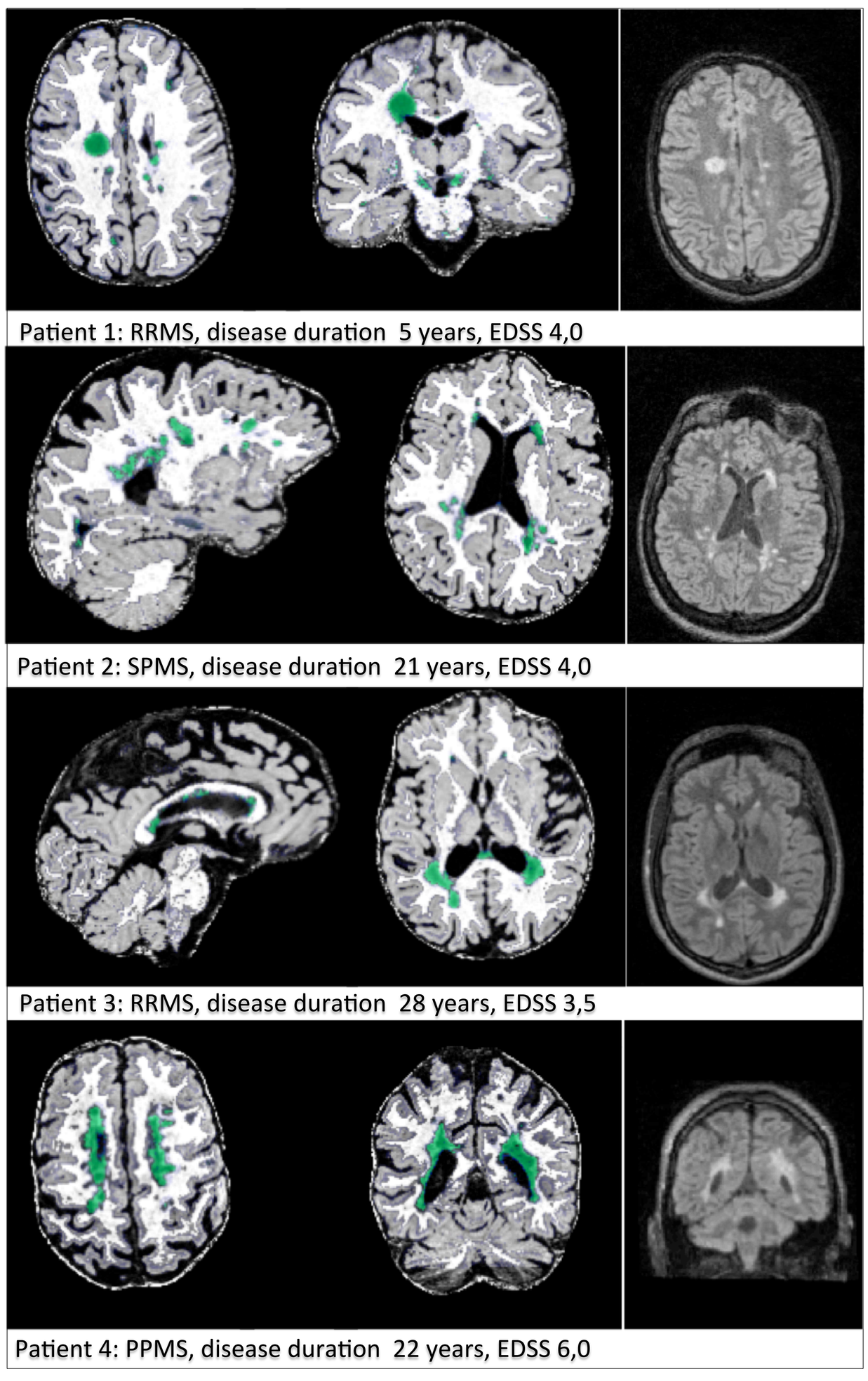

Figure 2. A posteriori probability maps obtained from 4 patients with different clinical courses and lesion loads compared to FLAIR 3D.

CONCLUSIONS

We have improved MR images segmentation in the presence of demyelinated lesions. This has been achieved by modifying standard TPM with individual information derived from the initial lesion mask. Further analyses will be needed to confirm the reliability of this technique. This will allow us to extract tissue parameters and to perform group-level statistical map analysis. We will also attempt to apply it to other white matter focal or multifocal cerebral lesions (stroke, brain tumor).

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