A SEMI-AUTOMATIC METHOD FOR MS LESION SEGMENTATION ON DUAL-ECHO MRI: APPLICATION IN A MULTICENTER CONTEXT

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INTRODUCTION and PURPOSE

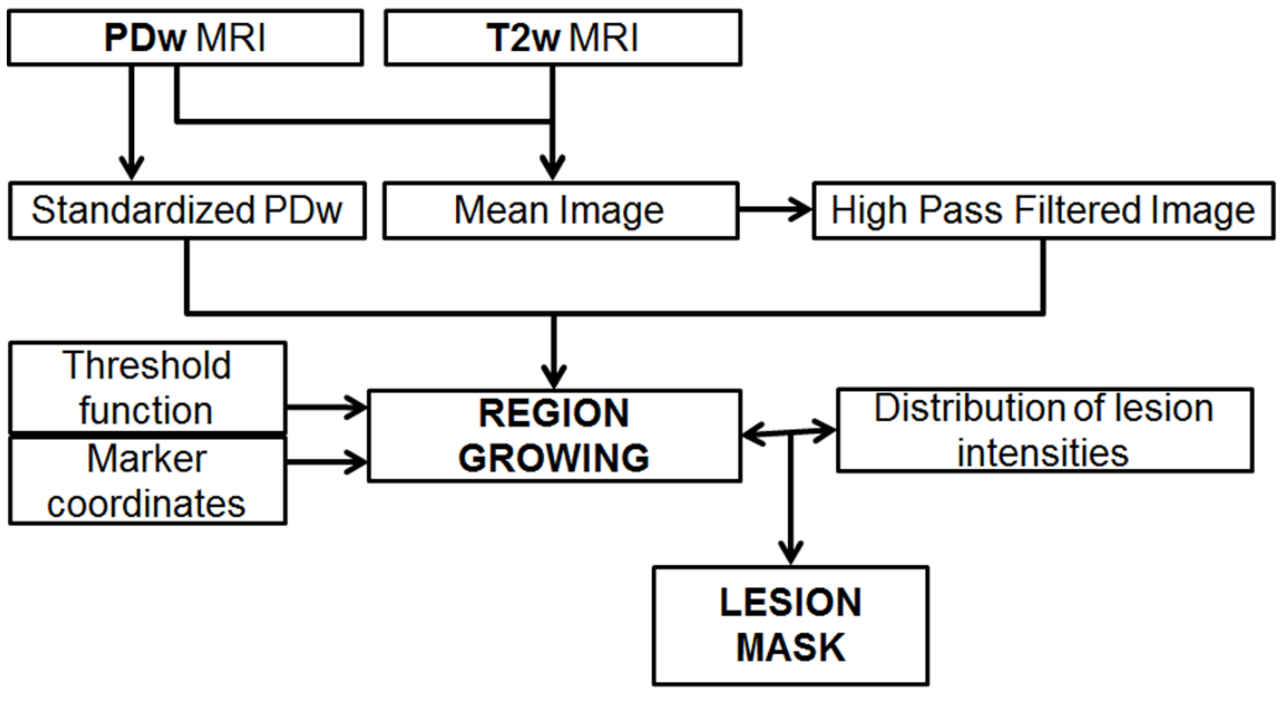
The assessment of the disease burden on MRI from patients with multiple sclerosis (MS) requires the quantification of the volume of hyperintense lesions on T2-weighted images [1].
Manual segmentation still remains the gold standard although it is time-consuming and introduces inter and intra-observer variability [2]. We proposed a semi-automatic method for MS lesion segmentation on dual-echo (DE) MR images [3].

Aims of this study were the training, optimization and validation of our semi-automatic lesion segmentation method on a MRI dataset of MS patients from different European centers.

METHODS

MRI Acquisition: 52 MS patients with DE turbo spin echo images were acquired in 6 European centers part of the MAGNIMS consortium (Milan, Naples, Siena, Amsterdam, London and Graz) from 3 MR manufacturers (GE, Philips, Siemens).
In **Figure 1,** a workflow of the lesion segmentation method is summarized.

Figure 1. Workflow of the semi-automatic method proposed.



Method: The MRI acquisitions were grouped according to scanner manufacturers. A different training to initialize the method was evaluated:
• Using a different sample size for each MR manufacturer;
• Using simulated threshold functions.
From these analyses, a general expression was extracted to replace the training step of the algorithm with a mathematical formulation for the threshold function based on image intensity features.

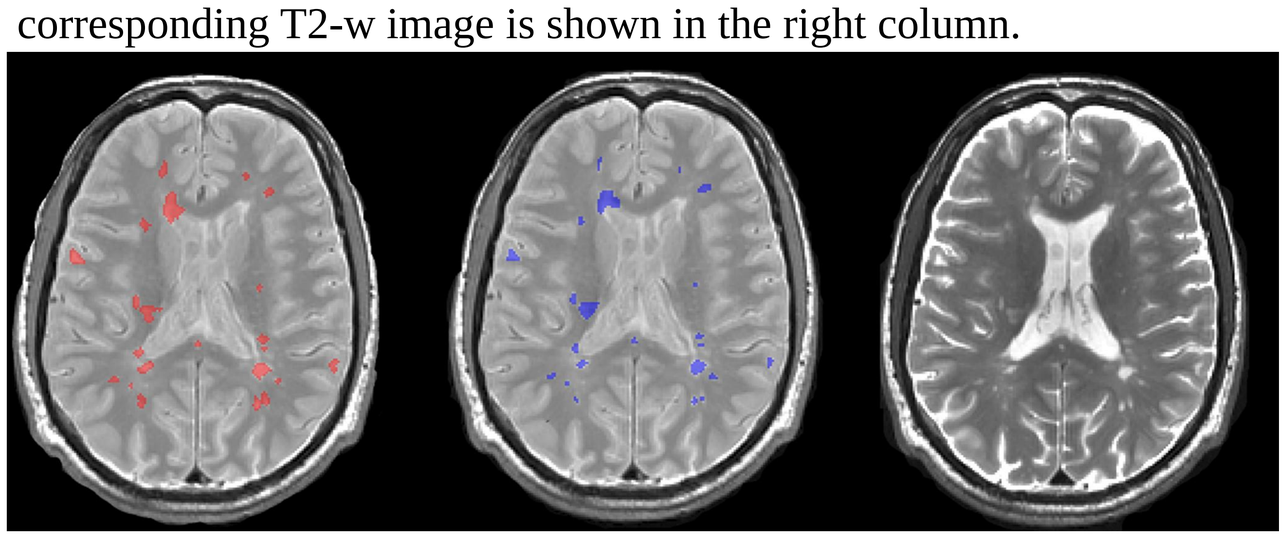
Statistical Analysis: Manual segmentation by an expert operator was used as the gold standard. The Wilcoxon-Mann-Whitney test was used to test for differences in segmentation errors between groups. Other metrics evaluated were Dice Similarity Coefficient (DSC), Root Mean Square Error of lesion load (RMSE), True Positive Fraction (TPF), False Positive Fraction (FPF), and False Negative Fraction (FNF) for each patient.

RESULTS

- No significant differences in lesion segmentation errors were found between MR manufacturers: p_{test1}**=0.65,** p_{test2}**=0.44 and** p_{test3}**=0.30** (Siemens *vs* Philips, Siemens *vs* GE and GE *vs* Philips).
- Mean metrics over all patients were: **DSC = 0.62; RMSE = 2 ml; TPF = 0.76; FPF = 0.36; FNF = 0.22.**

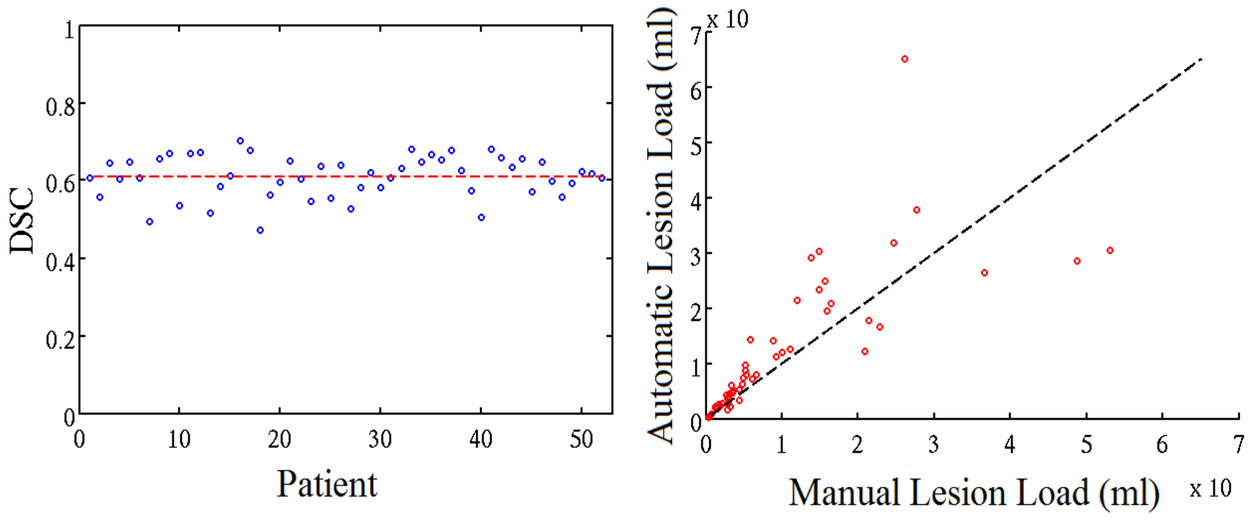
Figure 2 shows an example of lesion segmentation result.

Figure 2. Example of lesion segmentation performed by the proposed method (in red) compared to the manual one (in blue). The corresponding T2-w image is shown in the right column.



In **Figure 3** some metrics evaluated for each patient are graphically reported.

Figure 3. In the left graph DSC values are shown for each patient. In the right graph a scatter plot to compare manual lesion load against automatic lesion load is shown; the dashed line is the line of identity.



CONCLUSIONS

- **The method proved to be robust on data from different scanner manufacturers.**
- **No center-specific training was required, making the method applicable in clinical setting in the absence of manual lesion segmentation.**
- **Automatic lesion segmentation was very similar to the ground truth.**
- **Lower operator time will be required for image analysis in research and clinical trials in MS using the proposed method.**

REFERENCES

[1] Filippi et al., Arch Neurol 2011; [2] Garcia-Lorenzo et al., Med Image Anal 2013; [3] Storelli et al., BrainLes, MICCAI 2015.