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Abstract Title: Streamline RimNet: A Deep Learning Classification of Paramagnetic Rim Lesions

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Introduction:

Paramagnetic Rim Lesions (PRL) are Magnetic Resonance Imaging (MRI) biomarkers of smouldering inflammation in Multiple Sclerosis (MS). The manual assessment of PRL is time-consuming and shows high inter-rater variability. In order to standardise the PRL analysis, we previously proposed a 3D patched-based deep learning classification model, RimNet (Barquero, et al, 2020).

Objectives/Aims:

Our goals are to boost the use of RimNet by clinicians (to boost and ease manual annotations and RimNet predictions) and to evaluate the tool effectiveness and robustness as regards to variability of users' centre point selection in an out-of-domain dataset.

Methods:

We used the original RimNet model trained on 69 patients with T2* and FLAIR images from a 3T *Siemens Prisma* scanner (0.67mm isotropic resolution). We then evaluated RimNet in a different independent test set of 61 MS patients (19 males; 39 RRMS, 15 SPMS; 7 PPMS) from a 3T *GE Premier* scanner (0.67mm isotropic resolution). Following manual lesion annotation: 32 patients had 264 PRL (PRL^+) and 158 different MS manifestions (PRL^-), while 29 patients had no PRL^+. We developed an open source module in *3DSlicer* (Pieper, et al, 2004) that allows the rater to click on the centre of a lesion, provide an experience-based confidence rating and run the *Docker* implementation of RimNet. To study RimNet

robustness against patch selection, we extracted for each lesion multiple patches by translating the segmentation centre of mass up to 5 voxels in 3 directions. We show the AUC, True and False Positive Rate (TPR, FPR) in patient-wise average.

Results:

On the patients with both PRL$^+$ and PRL$^-$, at a 0 shift, the area under the curve (AUC_0) was 0.88±0.07, which decreased slightly but not significantly at a shift of ±1 and ±2 voxels (with $AUC_{\pm1\pm2}$ both at 0.87±0.04. All p-value >> 0.1). However, the performance steadily decreased towards a shift of 5 voxels (AUC_{+5}=0.79±0.06). TPR showed the same behaviour: 0.78±0.10 (0 shift), down to 0.42±0.09 (5 voxels shift), and FPR was quite stable: 0.24±0.11 (0 shift) to 0.25±0.05 (5 voxels shift). In patients with only PRL−, we had FPR of 0.10±0.05 (0 shift) and 0.04 ±0.02 (5 shift). No differences were found when stratifying the subjects by MS phenotype (p-value=0.45).

Conclusion:

RimNet is robust to the centre patch selection, as the clicked centre deviating from the actual lesion centre has a minor impact on model prediction. Furthermore, our approach demonstrated the robustness of RimNet trained and tested on data from different hospital and MRI scanner.

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