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**Abstract Title:** FLAWS against flaws: Improving Automated Cortical Lesion Segmentation

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## Introduction:

Cortical lesions (CL) are crucial magnetic resonance imaging (MRI) biomarkers for Multiple Sclerosis (MS) diagnosis and prognosis [Filippi et al. 2018]. However, their manual identification poses significant challenges even when specialized T1-weighted sequences are employed such as Magnetization Prepared 2 Rapid Acquisition Gradient Echoes (MP2RAGE) [Marques et al., 2010] and the novel FLuid And White matter Suppression (FLAWS) [Tanner et al. 2012].

## Objectives/Aims:

To develop and explore a fully automated method to detect and segment CL with FLAWS, building upon our previous manual identification study [Müller et al. 2022]. This represents the first exploration of such a method to our knowledge.

## Methods:

Our study includes 72 MS patients who underwent MP2RAGE and FLAWS MRI (Magnetom Prisma; Siemens Healthineers) at 3T with an isotropic spatial resolution (1mm<sup>3</sup>). CL were manually segmented on MP2RAGE and two reconstructed FLAWS contrasts (FLAWS-HCO and FLAWS-MIN) individually by 3 trained experts and refined through consensus. All images were skull stripped using SynthStrip [Hoopes et al. 2022] and MP2RAGE were patient-wise coregistered to the FLAWS space.

To evaluate the sensitivity for automated CL annotation of each sequence individually and their combinations, namely, MP2RAGE, FLAWS-HCO, FLAWS-MIN, the combination of the two FLAWS contrasts (FLAWS-ALL) and MP2RAGE+FLAWS-ALL, we trained 5 nnUNet [Insensee et al. 2021] models with 57 subjects. We chose nnUNet since it has shown superior performance for a big variety of segmentation tasks.

For the test subjects (n=15), we report averaged sensitivity and precision per patient for lesion detection performance metrics ( $S_L$ ,  $P_L$ ), and Dice coefficient (DSC) as overlapping metric.

## Results:

We summarize the results for the top-3 models. The MP2RAGE+FLAWS-ALL model showed the highest performance with  $DSC=0.43_{\pm 0.21}$ ,  $P_L=0.68_{\pm 0.18}$  and  $S_L=0.42_{\pm 0.15}$ , while the automated detection

performance for MP2RAGE was  $DSC=0.40_{\pm 0.20}$ ,  $P_L=0.74_{\pm 0.18}$ ,  $S_L=0.37_{\pm 0.16}$ , and for FLAWS-ALL was  $DSC=0.41_{\pm 0.22}$ ,  $P_L=0.55_{\pm 0.14}$ ,  $S_L=0.41_{\pm 0.12}$ .

**Conclusion:**

Our findings suggest that incorporating FLAWS information into MP2RAGE enhances the automated detection and segmentation of CL beyond what is achieved by FLAWS and MP2RAGE independently. Each contrast carries unique information about CL, which the model can effectively extract and combine automatically. Future work will explore the performance of this method when FLAWS images are reconstructed from MP2RAGE acquisitions.

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CT: nothing to disclose.

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NM: nothing to disclose.

FLR: nothing to disclose.

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MBC: nothing to disclose.

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