Physiological variability in brain electric conductivity: correcting the effect of the age for the detection of pathological alterations

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Overview

The aim of this work is to analyze the physiological variability of electric conductivity in the brain measured through electric properties tomography (EPT) using Magnetic Resonance Imaging (MRI). Electric conductivity maps of 27 healthy volunteers and 45 patients with pathologies of the white matter (WM) were estimated based on water content [Michel et al. (2017)] measured using MR Fingerprinting [Cencini et al. (2022)] (Fig. 1A).

For each subject, tissue class segmentation was performed to obtain a white matter mask (Fig. 1B) and the median conductivity within this region was measured. A non-linear mixed effect model was used to identify sources of variability. The inter-subject standard deviation of the median WM conductivity was estimated to 11 mS/m. The results in Fig 1C showed strong dependence of WM conductivity with age.

We reported higher WM conductivity in patients with respect to control subjects. To distinguish pathological changes from physiological variability, we established a threshold value of 22.5 mS/m more than the age-dependent average of observed

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in the control group (Fig. 1D). These findings are important for the development of biomarkers and personalized medicine using EPT, and demonstrate the potential of metrology in this field.

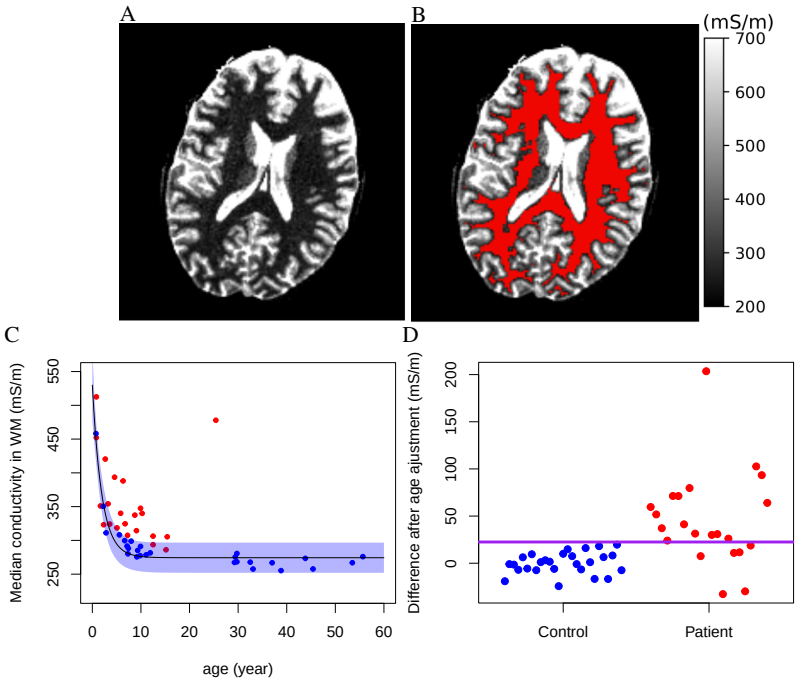

Fig. 1 A. Conductivity map on a transverse section for one subject. B. Segmentation of the white matter. C. Median conductivity in WM for each subject with respect to age (black line); The blue area is the prediction envelope at level 95%. D. For each subject, difference with the age-dependent average calculated from the control group (threshold in purple).

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