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Original

Physiological variability in brain electric conductivity: correcting the effect of the age for the detection of pathological alterations / Marmin, Sébastien; Arduino, Alessandro; Cencini, Matteo; Lancione, Marta; Biagi, Laura; Tosetti, Michela; Zilberti, Luca. - (2023), pp. 72-74. (Intervento presentato al convegno Joint workshop of ENBIS and MATHMET Mathematical and Statistical Methods for Metrology tenutosi a Torino nel 30-31 May 2023).

Availability:

This version is available at: 11696/76819 since: 2023-06-01T08:11:42Z

Publisher:

Published

DOI:

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

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Key words: Electric properties tomography, Quantitative imaging, Magnetic resonance imaging, white matter disorders

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.

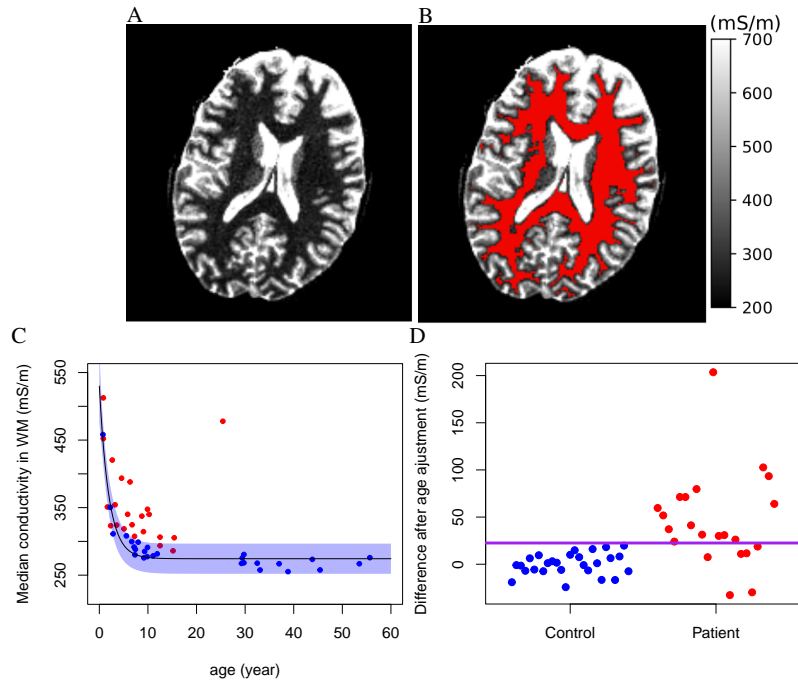


Fig. 1 A. Conductivity map on a transverse section for one subject. B. Segmentation of the white matter. C. Median conductivity in WM for each subject with respect to age (black line); The blue area is the prediction envelope at level 95%. D. For each subject, difference with the age-dependent average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

Acknowledgements This work was developed within the QUIERO project. This project has received funding from the EMPIR programme co-financed by the Participating States and from the European Union’s Horizon 2020 research and innovation programme. This study was also partially supported by grant RC and the 5x1000voluntary contributions to IRCCS Fondazione Stella Maris, funded by the Italian Ministry of Health.

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