



Differences in cortical activity in interictal, ictal, and chronic migraineurs

Marcelo Filipchuk^{1,2}, Mariela Carpinella¹, Tatiana Castro Zamparella^{1,3}, Diego Conci¹, Gianluca Coppola³, Jean Schoenen^{4*}, Marco Lisicki^{5,2}

¹Neuroscience Unit, Conci-Carpinella Institute, Córdoba, Argentina.

²Neurology Department, Hospital Universitario Ramón y Cajal, Madrid, Spain.

³Psychological Research Institute, Faculty of Psychology, National University of Córdoba (UNC) - National Council for Scientific and Technical Research (CONICET)

⁴Department of Medico-Surgical Sciences and Biotechnologies, Sapienza University of Rome Polo Pontino, Latina, Italy

⁵Headache Research Unit, Department of Neurology, University of Liège, Liège, Belgium

*Headache Laboratory, Instituto de Investigaciones Médicas Mercedes y Martín Ferreyra, Córdoba, Argentina.

Introduction

Migraine is a fluctuating disorder. Analyzing changes in cerebral activity at different stages of migraine has significantly advanced our understanding of its pathophysiology. However, most neuroimaging methods evaluate indirect markers of brain activation, such as regional metabolism or blood flow. In contrast, electrophysiological assessments provide direct information about underlying neuronal processes. This study aimed to compare cortical activity among interictal, ictal, and chronic migraine patients and healthy controls using an electrophysiological-based neuroimaging approach.

Materials and Methods

One hundred participants (25 healthy controls and 75 migraine patients: 25 ictal, 25 interictal, and 25 chronic) were included. A sixty-second low-artifact resting-state 22-channel electroencephalogram (EEG) segment from each individual was analyzed using Exact Low Resolution Brain Electromagnetic Tomography (eLORETA). Mean subject-normalized Delta, Theta, Alpha, Beta, and Gamma band activity was compared (whole brain, voxel-wise) between groups using Statistical Parametric Mapping (SPM) nested in MATLAB. Brain areas showing differences in neural activation were selected for data-driven post-hoc region of interest (ROI) analyses.

Results

Significantly decreased activity in the left subcallosal area was observed in ictal migraine patients compared to other groups. Additionally, increased activity in the right temporoparietal junction was noted in ictal migraine patients compared to interictal migraine patients, and increased activity in the left temporoparietal junction in interictal patients compared to healthy controls.

Conclusions

Our results are anatomically consistent, but mostly physiologically discordant with previous neuroimaging studies.⁽¹⁾ Notably, we observed increased neuronal activity in the right temporoparietal junction and decreased activity in the left subcallosal area in ictal patients, both areas previously reported to be activated in this stage using conventional neuroimaging techniques. We hypothesize that these discrepancies arise because inhibitory and excitatory neuronal activity produces similar metabolic changes, making them indistinguishable to conventional neuroimaging techniques, but easily discriminated using electrophysiological methods. The decreased activity in the left subcallosal area appears to be a homeostasis-restoring mechanism, absent in healthy controls and interictal patients, maximal in ictal patients, and dysfunctional in chronic migraine.