

P1.002

OPTICAL IMAGING OF SUBCELLULAR RESPONSES TO ELECTRIC FIELD STIMULATION USING GENETICALLY ENCODED INDICATORS OF NEURAL ACTIVITY

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Abstract

Transcranial electric and magnetic stimulation techniques allow for noninvasive delivery of electric fields (E-fields) to the brain, providing powerful approaches to probe brain function and treat psychiatric and neurological disorders. However, developing effective neuromodulation protocols for specific applications is difficult given the massive stimulation parameter space and persistent questions about how E-fields affect neural activity at the cellular and subcellular level. Electrical recording techniques suffer from the stimulus artifact obscuring activity during the stimulus and have limited access to fine axonal and dendritic processes. To overcome these limitations, we used genetically encoded voltage (Archon2) and glutamate (GluSnFR3) indicators to measure membrane polarization, AP propagation, and modulation of synaptic transmission by spatially uniform E-fields in dissociated hippocampal neuron cultures. We used high-speed (1–2 kHz) voltage imaging and sub-frame interpolation to estimate spatial propagation of action potentials induced by pulsed, suprathreshold E-field stimulation. Varying the E-field direction altered the site of AP initiation and sensitivity to E-field direction varied between cells. Using sub-threshold, dc pulses in the presence of TTX and TEA, we measured the distribution of steady-state membrane polarization. Neurons exhibited biphasic polarization distributions, with depolarization at the cathodal and hyperpolarization at the anodal side of the E-field, in line with theoretical predictions. Finally, we tested the effect of subthreshold, dc stimulation on glutamate release evoked by suprathreshold E-field pulses within individual presynaptic boutons. Subthreshold pulses acutely facilitated or suppressed the average magnitude of release in a subset of boutons as a function of intensity and polarity. These results demonstrate the utility of optical indicators of neural activity for studying the acute, subcellular effects of transcranial brain stimulation techniques, which, in combination with experimentally constrained computational models, can guide development of novel stimulation protocols.

Research Category and Technology and Methods

Basic Research: 10. Transcranial Magnetic Stimulation (TMS)

Keywords: Transcranial electric stimulation, Transcranial magnetic stimulation, Voltage imaging, Synaptic transmission

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Abstract key: PL- Plenary talks; S- Regular symposia oral; FS- Fast-Track symposia oral; OS- On-demand symposia oral; P- Posters

P1.003

QUANTITATIVE EEG (qEEG) IN PATIENTS WITH BIPOLAR PSYCHOTIC DEPRESSION AND UNIPOLAR PSYCHOTIC DEPRESSION UNDER ELECTROCONVULSIVE THERAPY (ECT)

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Abstract

Introduction: In the last 21 years, there has been an increase in studies on quantitative electroencephalogram (qEEG) in psychiatry. Patients with unipolar and bipolar depression show different brain wave patterns. However, there is no consensus on the findings. In this study, we aimed to clarify some qEEG changes in patients with unipolar psychotic depression (UPD) and bipolar psychotic depression (BPD) during the ECT course.

Methods: 10 patients undergoing treatment with ECT were considered. Of the 128 total ECT sessions, 34 sessions from six patients included had valid EEG recordings (3 patients with UPD and 3 with BPD, some with catatonic features). They underwent bifrontal ECT on a Thymatron IV device. EEG data were digitally recorded from two frontal leads with a Thymatron device and the Genie software. Data were analyzed with WinEEG soft package. EEG activity was divided into 4 phases: 1) background (resting state); 2) anesthesia; 3) ECT-induced stimulation/seizure, and 4) recovery. Regression analysis was performed for each phase through the sessions. The following EEG power spectrums were analyzed: delta (1.5–3.75 Hz), theta (4–7.75 Hz), alpha1 (8–9.75 Hz), alpha2 (10–13 Hz), beta1 (13.25–18 Hz), and beta2 (18.25–30 Hz).

Results: Patients with psychotic unipolar depression showed an increase in the power spectrum of beta1 and/or beta2 in the resting phase over time ($p < 0.05$, linear regression). This increase was linked with clinical improvement. Patients with bipolar psychotic depression did not show this activity.

Conclusion: Clinical improvement in patients with unipolar psychotic depression was linked to an increase in the beta power spectrum. The same does not occur in bipolar patients. One possible reason for this finding might be that some bipolar patients have an increased basal beta activity. However, more studies are needed to assess the significance of our findings.

Research Category and Technology and Methods

Clinical Research: 15. Electroencephalography (EEG)

Keywords: Quantitative electroencephalography, Electroconvulsive Therapy, Bipolar psychotic depression, Unipolar psychotic depression

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P1.004

SUDDEN AND TRANSIENT BLOCK OF LEFT BRAIN HEMISPHERE ACTIVITY IN CATATONIC PATIENTS UNDERGOING ELECTROCONVULSIVE THERAPY (ECT)

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Abstract

Introduction: In the last 21 years, there has been an increase in studies on visual and quantitative EEG (qEEG). Although new findings have been reported, such as the extreme delta brush waves in anti-NMDA receptors encephalitis, there are still undocumented visual EEG alterations. In Psychiatry, these new findings are harder to detect because most patients do not undergo routine EEG. In this work, we report for the first time an EEG finding of a sudden and transient block of left brain hemisphere activity in two patients who underwent treatment with ECT.

Methods: The EEG activity of the two patients undergoing ECT treatment was recorded using a Thymatron System IV device. Patient number 1: 23 year-old man with severe major depressive disorder with psychotic features and catatonia. Patient number 2: 48 year-old woman with bipolar disorder with mixed features and catatonia.

Results and Discussion: The EEG recording of these two patients during their ECTs sessions showed a sudden and transient block (or arrest) of the left brain hemisphere activity. These findings are not attributed to background noise, electrode disconnection or device malfunction. Also, they were detected in two different patients. In patient 2 in two distinct admissions, two hospitals, utilizing two devices and by two different observers. After clinical improvement, these EEG alterations were not detected.

Conclusion: To our knowledge, this is the first report of a sudden and transient block of the left brain hemisphere activity in psychiatric patients. Although the exact meaning of this finding remains unknown, a comparison can be made between this transient bradypsychia/block (arrest) of brain activity and bradycardia events in cardiology. We acknowledge the need for further studies to better understand these findings, particularly studies addressing different EEG abnormalities and the clinical traits they are associated with.