PAPER OF THE MONTH 12/2023

TRR 295 ReTune

Local Field Potentials Predict Motor Performance in Deep Brain Stimulation for Parkinson's Disease.

Busch JL*, Kaplan J*, Bahners BH, Roediger J, Faust K, Schneider GH, Florin E, Schnitzler A, Krause P, Kühn AA. *equal contribution

Mov Disord. 2023; 38(12): 2185-2196. doi: 10.1002/mds.29626. PMID: 37823518.

With technological advances in deep brain stimulation (DBS) systems, clinical programming is becoming more and more challenging. This is especially true for directional DBS electrodes, in which twice as many contacts must be assessed compared to conventional electrodes. The gold standard for clinical programming of Parkinson's disease (PD) patients with DBS is the monopolar review, where every contact is tested for its clinical efficiency by subsequently increasing the stimulation amplitude. However, this is a time-consuming process and requires highly trained personnel. Hence, there is a need for data-driven approaches aiding clinical programming..

A recent technological innovation in deep brain stimulation has been the introduction of sensing-enabled DBS systems allowing for simultaneous stimulation and recording of local field potentials (LFPs). This technology allows to extract electrophysiological biomarkers at the site of electrode implantation. In our study, we included 16 PD patients implanted with directional electrodes in the STN and sensing-enabled implantable pulse generators (IPGs). We investigated the potential of LFPs and their modulation by DBS for guiding clinical programming in PD. Since beta power has been shown to correlate with the severity of bradykinesia-rigidity, we hypothesized that contacts with higher beta power (off stimulation) and with more pronounced beta suppression (with stimulation) are better suited for chronic stimulation. Recordings took place three months after surgery after overnight withdrawal of dopaminergic medication. We recorded LFPs with (1) the stimulation turned off and (2) during a monopolar review with stimulation applied over directional and ring electrodes. Motor performance was assessed with a pronation-supination task.

We could show that directional DBS suppresses beta power and improves motor performance in a similar way to conventional DBS and that beta suppression correlates with movement velocity and amplitude. Furthermore, differences in directional beta power and the extent of stimulation induced beta suppression across directional contacts predicted motor performance. When comparing beta power and beta suppression, we found that beta suppression was more closely related to the optimal stimulation contact and that only beta suppression correlated with the contacts selected for chronic stimulation by blinded clinicians. We conclude that electrophysiological biomarkers may guide DBS programming for PD patients. For this, stimulation induced beta power suppression seems to be superior to beta power. In the future, combining electrophysiology- and imaging-based approaches into a multimodal data-driven algorithm for DBS programming may yield additional benefit and further aid clinicians in the management of PD patients.

Johannes Busch

Johannes Busch is a medical doctor working at the Movement Disorders and Neuromodulation Unit at Charité Berlin. His main research interest is invasive human neurophysiology in movement disorders. He is currently working on adaptive deep brain stimulation in project C04.

Jonathan Kaplan

Jonathan Kaplan is a medical student at Charité – Universitätsmedizin Berlin and works on his thesis at the Movement Disorders and Neuromodulation Unit. He investigates local field potentials recorded with sensing-enabled DBS systems in patients with movement disorders. Jonathan has also been supporting ReTune project C04 (adaptive DBS).

RETUNE

CRC TRR 295 Berlin-Würzburg