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Brain Machine Interface and Imaging

#8426

Adaptive Deep Brain Stimulation in Parkinson's Disease, First Results

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Introduction: Classical DBS treatment of Parkinson disease (PD) involves constant stimulation by electrodes localized in deep brain structures such as the sub thalamic nucleus or the internalpalladium. This constant stimulation may be suboptimal facing the fact that movement planning and execution involves sequential parietofrontal network activation that is expressed by modulation of EEG beta-band oscillation often referred as event-related desynchronization and synchronization (ERD/ERS). Indeed constant stimulation of the STN is not without secondary sometimes dramatic secondary effects. In this context adaptive DBS, where stimulation is triggered by certain neurophysiological markers, has emerged as an improvement over conventional systems. It may reduce the amount of energy received by the patient and also theoretically the side effects.

Methods and Results: We recorded brain activity from the subthalamic nucleus via the deep electrodes while stimulating simultaneously. This was made possible because of the design of a custom-made system that allowed filtering out stimulation artefacts from the underlying brain signals. Tests of the closed-loop adaptive DBS have been performed in 3 PD patients. The protocol consisted of three stimulation conditions over 3 days: continuous (normal), adaptive, and no stimulation, whereby each condition was 20 min long. A blinded neurologist evaluated the clinical assessments of the motor effect via the Unified Parkinson's disease rating scale (UPDRS) before, during, and after each condition. In the no-stimulation condition, we found a pathological synchronization of the beta band in both hemispheres and a strong coherence between both hemispheres in the high-beta and low-gamma band. Therefore, detection of increased (over the 50 percentile) beta band activity (22–28 Hz) was used to trigger the stimulation in the adaptive condition. When compared, subject-specific closed loop stimulation yielded similar efficiency to conventional continuous DBS.

Discussion: Our initial results demonstrate that we can successfully record local field potentials, detect the physiological biomarkers of motor symptoms in PD patients and adaptively trigger the DBS with the same efficacy as constant stimulation. Nevertheless, more subjects and tests over longer periods of time are necessary to confirm the preliminary observations on the efficacy of adaptive DBS.

Significance: Closed-loop adaptive DBS is possible which opens up strategies to better tune the stimulation leading to increased battery life and better control over symptom variations.

#8446

Targeting Accuracy of the Subthalamic Nucleus in DBS Surgery: Comparison between 3T MRI and Microelectrode Recording Results

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Keywords: DBS, Subthalamic nucleus, Targeting, Microelectrode recording.

Backgorund: Targeting accuracy in DBS surgery is defined as the level of accordance between the selected target and the anatomically real target reflected by characteristic electrophysiological results of microelectrode recording (MER). We aimed to determine the correspondence between the preoperative predicted target based on modern 3Tesla T2-weighted magnetic resonance imaging sequences and intraoperative MER results separately on the initial and consecutive second side of surgery.

Methods: We retrospectively analyzed 86 trajectories of DBS electrodes implanted into the subthalamic nucleus (STN) of patients with advanced Parkinson's disease. The entrance point of the electrode into the STN and the length of the electrode trajectory crossing the STN was determined by intraoperative MER findings and 3T high-resolution T2-weighted magnetic resonance images with 1 mm slice thickness.

Result: The average difference between MRI-based and MER-based trajectory length crossing the STN determined in each patient was 0.28 ± 1.02 mm (–0.51 to –0.05 mm 95% CI). There was a statistically significant difference between the MRI- and MER-based entry point on both the initial and second side of surgery ($p = 0.04$). 43% of the patients had a difference of more than > 1 mm of the MRI-based predicted and the MER-based determined entry point into the STN with values ranging from –3.0 to + 4.5 mm.