static delivery of stimulation (conventional, cDBS), that is kept with constant parameters throughout the day, while, on the contrary, PD symptoms fluctuate. From this, adaptive DBS (aDBS) was conceived as a new type of DBS, introducing a closed-loop delivery of stimulation, aimed to follow the patient's clinical state thus providing the right stimulation and avoiding overstimulation and side effects. Among the possible control variables for this closed-loop approach, the electrical activity of the brain structure where the DBS electrode was implanted, local field potentials, LFPs, were chosen as a reliable neurophysiological biomarker. We now present clinical data from the first patients chronically treated (over six months) with one of the two devices currently available for aDBS delivery, AlphaDBS (Newronika) and Percept PC/RC (Medtronic). We will discuss programming modalities and challenges, the evolution of the LFPs signal over time and its clinical correlations, technical limitations and drawbacks. Preliminary data comparing the clinical benefits of aDBS versus cDBS modality will also be discussed.

Research Category and Technology and Methods

Clinical Research: 7. Responsive (Closed-Loop) Stimulation

Keywords

Adaptive DBS, local field potentials, long follow-up, biomarkers

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FS3G.2

TASK-RELATED BIOMARKERS AND TECHNICAL DEVELOPMENTS FOR ADAPTIVE DEEP BRAIN STIMULATION IN PARKINSON'S DISEASE

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Symposium title

Advances in adaptive DBS: from animal models to clinical practice

Abstract

Despite the great efficacy of deep brain stimulation (DBS) in improving the motor symptoms of Parkinson's disease (PD), a subgroup of patients experience deterioration in gait and speech after surgery, a complication with still little known underpinnings. New devices that can provide adaptive stimulation (aDBS) have made it possible to record chronically stimulated patients as they perform complex motor tasks in the context of daily life. The new frontier of deep brain stimulation is to implement stimulation adapted to daily fluctuations in symptoms and modulated by the motor and non-motor activities of daily living. We now present preliminary recording data of local flied potentials (LFPs) during spontaneous speech recordings and gait modulation tasks. We will also describe the chronic effect on gait of different stimulation paradigms (high and low frequency) and stimulation modes, aDBS and conventional (cDBS). Finally, we will discuss the technical difficulties in implementing new task-related biomarkers, the necessary technological developments, and new AI algorithms for predicting the evolution of symptoms and motor performance over time in parkinsonian patients undergoing chronic treatment with aDBS.

Research Category and Technology and Methods

Translational Research: 7. Responsive (Closed-Loop) Stimulation

Keywords

Adaptive DBS, local field potentials, gait, speech

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FS3G.3

CLOSED-LOOP DEEP BRAIN STIMULATION BEYOND PARKINSON'S DISEASE: OPPORTUNITIES, BIOMARKERS AND BRAIN SIGNAL DECODING

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Symposium title

Advances in adaptive DBS: from animal models to clinical practice

Abstract

Closed-loop adaptive deep brain stimulation combines invasive brain signal recordings with a therapeutic control algorithm to provide individualized treatment adjustments in real-time. In Parkinson's disease, the identification of pathological beta oscillations with their potential to signal concurrent symptom severity and therapeutic response has inspired this advancement. Sensing enabled DBS devices now allow for continuous and repeated recordings with the potential to identify neural signatures of pathophysiological mechanisms and symptom specific physiomarkers. However, only few studies have capitalized on these opportunities to study the potential and opportunities of adaptive DBS beyond PD. In the last decade, our team has invasively recorded brain signals in hundreds of patients with diverse brain disorders, including dystonia, major depressive disorder, obsessive compulsive disorder, Tourette's syndrome and epilepsy from various DBS target areas. We have identified signatures of concurrent symptom severity and investigated the potential of multivariate brain signal decoding for advanced machine learning based clinical brain computer interfaces that can adapt to the individual situations that patients are facing, with an unprecedented spatiotemporal precision.

Research Category and Technology and Methods

Clinical Research: 7. Responsive (Closed-Loop) Stimulation

Keywords

Deep brain stimulation, Brain computer interface, Neurotechnology, Neuropsychiatry

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FS3G.4

BIOMARKERS FOR DEEP BRAIN STIMULATION IN ANIMAL MODELS OF MOVEMENT DISORDERS

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Symposium title

Advances in adaptive DBS: from animal models to clinical practice

Abstract

Elevated beta (13-35 Hz) synchronization between the motor cortex (MCx) and subthalamic nucleus (STN) is associated with bradykinesia in Parkinson's disease (PD). These beta oscillations are considered potential biomarkers for motor symptoms during off-medication periods and may serve as control signals for adaptive, closed-loop deep brain stimulation (DBS). However, their relationship with striatal dopaminergic degeneration and disease progression remains unclear. Current studies on beta oscillations primarily focus on advanced PD stages in patients undergoing DBS, limiting insight into early-stage disease progression and compensatory mechanisms. Here animal disease models come into play. We will discuss the advantages of utilizing animal models of movement disorders, specifically focusing on PD. We will present data on beta oscillatory dynamics in these models and their correlation with motor performance and the extent of nigrostriatal neurodegeneration. Moreover, by using a progressive, α-synuclein-based rat model of PD we will demonstrate the