464

Predicting Sleep Quality Improvement in Parkinson's Disease Patients Post-DBS: A Nomogram Approach

Bowen Chang; Benjamin C. Sherman; Vivek Buch, MD; Chaoshi Niu

INTRODUCTION: Sleep disorder is a common concomitant symptom of Parkinson's disease (PD).

METHODS: We retrospectively analyzed the medical records and questionnaire responses of 468 patients with PD who received DBS of the subthalamic nucleus (STN) between 2017 and 2020. These patients were categorized into two groups based on whether their PD Sleep Disorder Scale (PDSS) scores showed improvement three years post-surgery: the improved group and the non-improved group. To identify factors that influence sleep disorder improvement, we conducted both univariate and multivariate regression analyses. Subsequently, we developed a nomogram to predict the likelihood of sleep disturbance improvement. We assessed the nomogram's accuracy and predictive performance through calibration plots, Receiver Operating Characteristic (ROC) curves, and Decision Curve Analysis (DCA).

RESULTS: Patients who experienced improvement in sleep disorders following surgery showed better preoperative responses to medication, higher Mini-Mental State Examination (MMSE) scores, and lower Hamilton Anxiety Scale (HAMA) scores, despite having poorer PDSS scores compared to those without post-surgical sleep disorder improvement. Further analysis using univariate and multivariate regression identified preoperative medication responsiveness, MMSE, HAMA, and PDSS score as independent predictors of postoperative PDSS score improvement in PD patients. Utilizing these findings, we developed a nomogram model, which demonstrated a strong predictive accuracy with an area under the ROC curve of 0.78 (95% CI: 0.69–0.88). Calibration plots and decision curve analysis confirmed the nomogram's excellent alignment between predicted outcomes and actual observations.

CONCLUSIONS: A nomogram was developed to forecast the likelihood of sleep disorder improvement in PD patients three years following DBS of the STN. This tool may hold significant value in prognosticating sleep quality in PD patients after DBS.

465

Classifying At-Home Movement States Using Cortical-Pallidal Neural Activity in Parkinson's Disease

Rithvik Ramesh; Hamid Fekri Azgomi; Kenneth Louie; Jannine Balakid; Doris D. Wang, MD, PhD

INTRODUCTION: The development of adaptive deep brain stimulation (aDBS) for Parkinson's disease (PD) to automatically change stimulation from conventional to 'gait-optimized' frequency settings when patients walk is challenged by the lack of neural biomarkers of movement states in naturalistic environments.

METHODS: A bi-directional neurostimulator (Summit RC+S, Medtronic) was used to record unilateral activity from the globus pallidus (GP), premotor cortex (PM), and primary motor (M1) cortex in two PD patients. Wearable ankle accelerometers (Rover Health) were used to record at-home kinematic data. Rover and RC+S signals were synchronized, and spectral analysis of 10-second epochs of continuous walking and non-walking was performed. Linear discriminant analysis (LDA) models were trained to classify movement states using average power within all possible frequency bands from 1 to 50 Hz during each epoch. The most important features determined by random forests (RF) were used to create 'system-constrained' LDA models meeting the specifications of the RC+S on-board classifier.

RESULTS: Over 16 hours of data were analyzed (subject 1: 10.75 hours, subject 2: 5.7 hours). Spectral profiles of movement state differed between the two subjects. While one exhibited broadband differences across multiple frequency ranges in cortical-pallidal signals between states, the second patient displayed more focused decreases in M1 beta band (13–30 Hz) power during walking periods. Models achieved areas under the curve (AUC) greater than 0.80 in both subjects when trained with all potential frequency bands. 'System-constrained' classifiers performed with AUC greater than 0.70 for both individuals.

CONCLUSIONS: Our findings support the hypothesis that motor cortex and basal ganglia oscillations are modulated by movement state. These novel methods offer a pipeline for identifying patient-specific movement state biomarkers using long-term naturalistic recordings of neural and kinematic activity.

466

Deep Brain Stimulation of Nucleus Basalis of Meynert: Different Activation Patterns Results in Varying Spectral Topography in Cortex

John Preston Wilson; Greyson Jadwin; Jamie Toms; Kathryn Holloway; Deepak Kumbhare

INTRODUCTION: Deterioration of the basal nucleus of Meynert (NBM) is a key feature associated with dementia. The cholinergic projections of NBM serve as the primary source of Acetylcholine (ACh) for the entire neocortex. Research has demonstrated that NBM enhances cortical activity by influencing ACh release, which in turn affects neuroexcitability, spectral topography, and intra-cortical signaling in the neocortex. Moreover, NBM neurons have been observed to modulate their firing patterns during various cognitive processes.

METHODS: (i) Various NBM stimulation parameters were tested in anesthetized adult rats. Default stimulation parameters were cathodic monopolar pulse with phasic patterns, 10 pulse/train with 100 ms train duration, train frequency of 100 Hz (inter-pulse frequency, IPF), and train repetition rate of 4 Hz (inter-burst frequency, IBF). (ii) In a separate experiment, the NBM-local field potential (LFP) and EEG from the auditory cortex (A1) were recorded from tethered normal, demented, and stimulated demented rats during audio tasks.

RESULTS: (i) When different IBFs were tested, we saw a peak in the theta power at the 4–6 Hz range with the corresponding decrease in delta. The drastic reduction at 2 and 6 Hz indicates the circuitry's resonance sensitivity. Similarly, for different IPFs, the same pattern of a peak in theta and reduction in the delta was found at an IPF of 50–60 Hz. The pulse-width response was maximized at 6–8 ms. (ii) The different activation levels of NBM regulate the cross-frequency coupling strength of the NBM-cortical network.

CONCLUSIONS: The present findings suggest that naturalistic NBM burst DBS may offer an effective therapy for treating dementia and