Neurophysiological Biomarkers of Dorsal and Ventral Subthalamic Nucleus in Parkinson's Patients

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Introduction

- Deep brain stimulation (DBS) of the subthalamic nucleus (STN) is a well-established therapy for the motor symptoms of Parkinson's disease (PD).
- The STN has traditionally been divided into a dorsal sensorimotor region- a desired target with DBS- and a ventral limbic and associative region.
- Boundaries between functional regions in the STN are variable and not always well-defined. While many studies have differentiated the dorsal and ventral STN anatomically, only few have studied neurophysiologic characteristics of the ventral and dorsal STN in PD patients.

Objective

- Identify neurophysiologic biomarkers that can help differentiate the dorsal and ventral STN, which can help guide optimal intraoperative electrode placement and postoperative programming.

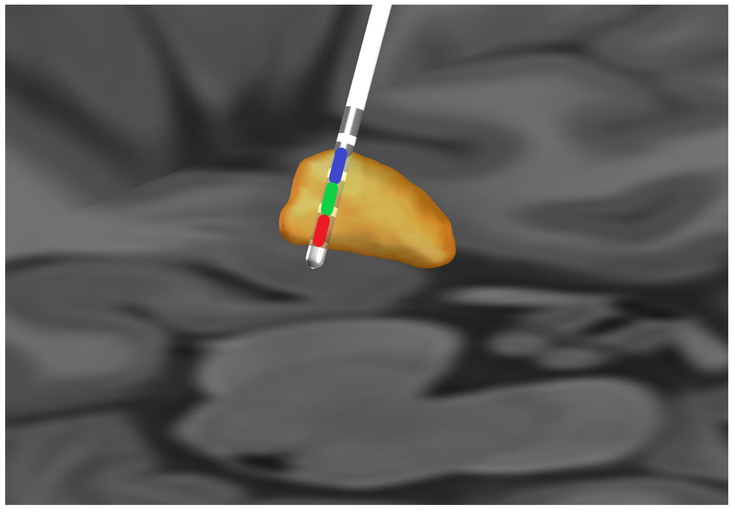

Figure 1. Example subthalamic nucleus and microelectrode trajectory, created using Lead DBS. Blue - dorsal 1/3 of STN segment; green – middle 1/3 of STN segment; red – ventral 1/3 of STN segment.

Methods

- Intraoperative microelectrode recordings (MERs, NeuroOmega) of 14 STNs from 11 PD patients were divided into 500 ms bins.
- Mean beta (14-30 Hz), low gamma (30-80 Hz), high gamma (80-200 Hz), and broadband (2-200 Hz) powers were compared to the mean spiking band (300-3000 Hz) power[8] for each bin at each recording depth corresponding to the STN.
- The recording depths corresponding to the dorsal one-third and ventral one-third STN were defined as the dorsal and ventral STN segments, respectively.
- Pearson correlation coefficients between each band and spiking band powers for the dorsal and ventral STN segments were assessed for differences in either significance ($p < 0.05$) or directionality.

Results

- Correlation coefficients in the dorsal and ventral STN for beta vs. spiking band power differed in significance and/or directionality for 11 STNs.
- Correlation coefficients in the dorsal and ventral STN for low gamma vs. spiking band power differed in significance and/or directionality for 8 STNs.
- Correlation coefficients in the dorsal and ventral STN for high gamma vs. spiking band power differed in significance and/or directionality for 4 STNs.
- Correlation coefficients in the dorsal and ventral STN for broadband vs. spiking band power differed in significance and/or directionality for 5 STNs.

Conclusion

- The dorsal and ventral STN appear to have unique electrophysiologic fingerprints that allow them to be distinguished using intraoperative MERs

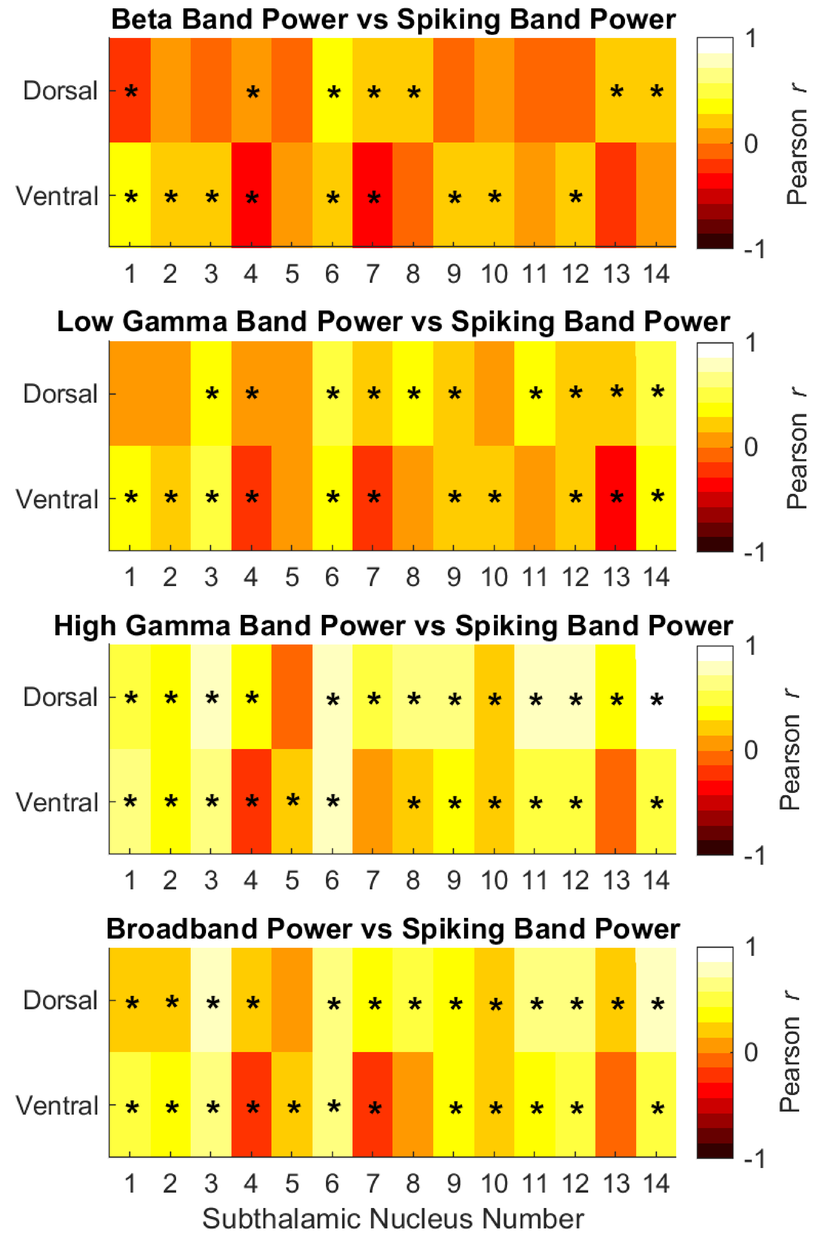

Figure 2. Summary of beta, low gamma, high gamma, and broadband powers versus spiking band power for the dorsal and ventral segments of each subthalamic nucleus. An asterisk indicates a statistically significant correlation.

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