Spectral Analysis of Local Field Potentials in a Patient with Essential Tremor Treated with Deep Brain Stimulation in the Ventral Intermediate Nucleus of the Thalamus

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Adriana Lucia Lopez Rios,[1] William Duncan Hutchison,[2] Juan Sebastian Saavedra Moreno,[3] Daniel Henao Lopez,[4] Manuela Jaramillo Quintero,[5] Manuela Pelaez Soto,[6] Luis Fernando Botero Posada,[7] Carlos Anibal Restrepo Bravo.[8]

[1] Hospital San Vicente Fundacion Rionegro. Functional and Stereotactic Neurosurgery Department.
[2] Division of Neurosurgery, Department of Surgery, Toronto Western Hospital, Universtiy Health Network. Canadá.
[3] Hospital San Vicente Fundacion Rionegro. Department of Neurology. Movement Disorders.
[4] University of Toronto. Department of Physiology. Canadá.
[5] Hospital San Vicente Fundacion Rionegro. Department of Dietist.
[6] Hospital San Vicente Fundacion Rionegro. Neurosychology Department.
[7] Hospital San Vicente Fundacion Rionegro. Department of Neuroanesthesia.
[8] Universidad CES. Facultad de Medicina. Neurofisiologia.

Corresponding author: Adriana Lucia López Ríos email:Adrilori@Yahoo.Com

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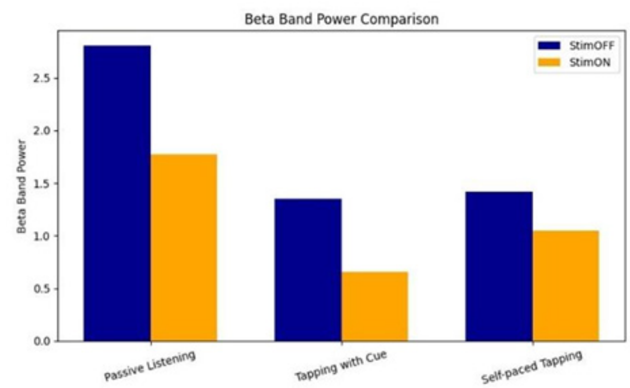
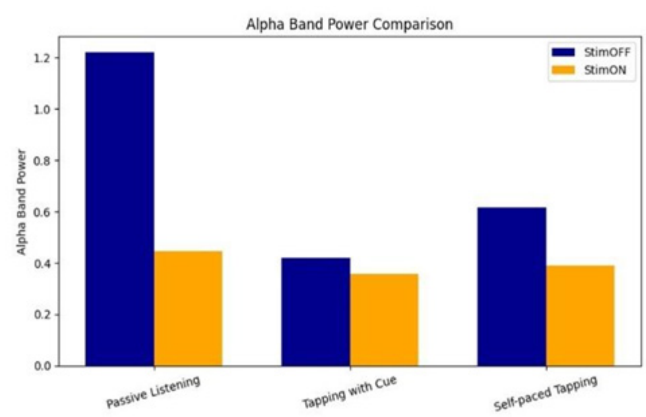
Abstract





Introduction: Deep Brain Stimulation (DBS) of the ventral intermediate nucleus (VIM) of the thalamus is an established therapy for medically refractory essential tremor. Since 2014, 18 patients have undergone bilateral VIM DBS at our center in San Vicente Fundacion Rionegro Colombia. The recent availability of sensing devices such as the Percept RC has enabled direct analysis of local field potentials (LFPs) in vivo. We are presenting the characterization of the spectral dynamics of thalamic LFPs in our last patient with essential tremor implanted with the Percept RC system, comparing stimulation OFF and ON states across motor tasks.

Method: A 72-year-old male with familial essential tremor underwent bilateral VIM DBS with a Percept RC neurostimulator. LFPs were recorded during three motor tasks: passive listening (15–45s), tapping with auditory cue (50–87s), and self-paced tapping (88–120s). Power spectral density (PSD) was computed using Welch's method. Band-specific power was extracted for delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (30–100 Hz) bands. Peak frequency was also identified.

Results: Resultados: Results: DBS ON induced distinct spectral changes. In passive listening, peak frequency shifted from 10.01 Hz to 23.19 Hz, with reduced alpha and beta power. During tapping with cue, low-frequency bands remained dominant, with slight increases in delta and theta. In self-paced tapping, peak frequency dropped from 21.73 Hz to 3.17 Hz, with increased delta and theta power and reduced alpha and beta activity. These findings suggest DBS modulates thalamocortical rhythms differently across motor states.

Discusión: The spectral analysis may reveals that DBS stimulation induces significant modulation of thalamocortical activity. In passive listening, stimulation shifts the dominant frequency toward higher beta ranges while suppressing overall band power, suggesting a state of cortical desynchronization. During motor tasks, particularly self-paced tapping,

DBS appears to reduce high-frequency activity and enhance low-frequency bands, possibly reflecting altered motor planning and execution. These observations may support the role of DBS in reshaping neural oscillatory dynamics and may support future strategies for optimizing stimulation parameters in essential tremor therapy.

Conclusions: The observations on this case could show the feasibility of LFP spectral analysis using Percept RC in essential tremor. DBS alters oscillatory dynamics in a task-dependent manner, supporting its role in motor circuit regulation. These insights may inform future strategies for adaptive DBS and biomarker development.

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