

Lead-DBS Demonstrates Sensory-Motor Nucleus Stimulation: A Real-Life Simulation of a Computerized Tool in Parkinson's Disease

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Abstract

Introduction: Medical literature consistently identifies the sensorimotor region within the subthalamic nucleus (STN) and internal globus pallidus (GPi) as the optimal targets for Deep Brain Stimulation (DBS) in Parkinson's disease. Accurate electrode placement and adequate stimulation of these regions are directly associated with better clinical outcomes. To assess surgical precision and stimulation effects, neuroimaging-based software tools such as Lead-DBS can localize electrode positions and estimate the volume of tissue activated (VTA). In this study, we applied Lead-DBS to a real-life Parkinson's disease population to analyze electrode localization, simulate VTAs, and visually confirm stimulation overlap with the sensorimotor subregions.

Method: We conducted a cross-sectional analysis of patients with Parkinson's disease who underwent DBS surgery at a Brazilian neurosurgical center between 2022 and 2025. Preoperative high-resolution MRI and postoperative CT scans were processed using Lead-DBS software (version 3.2), following a standardized workflow including image coregistration, spatial normalization, and semiautomatic electrode reconstruction. 'Sweetspot' mapping was then conducted, taking into account the latest individual stimulation parameters. To improve anatomical interpretation, VTA data were exported to the 3D Slicer software (Version 5.8), overlaid on a T1-weighted atlas, and rendered using color-graded filters representing activation intensity.

Results: Nineteen patients (38 electrodes) were included in the study, with 12 cases targeting the STN and seven targeting the GPi. Group electrode reconstruction demonstrated close anatomical proximity to the intended sensorimotor targets. Sweetspot simulation revealed predominant stimulation of the dorsolateral portion of both the STN and GPi, corresponding to the sensorimotor subregions.

Discussion: Lead-DBS has proven to be a practical and accessible tool for postoperative electrode localization and sti-

mulation field visualization in a real-life clinical population. The observed stimulation patterns were aligned with the established sensorimotor target zones reported in the literature. Nevertheless, further studies are warranted to validate its clinical predictive value.

Conclusions: Lead-DBS effectively demonstrated stimulation of the sensorimotor subnuclei in a real-life Parkinson's disease population, reinforcing its utility for anatomical and functional visualization in DBS surgery.

References

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