Deep Brain Stimulation for Disorders of Consciousness after Global Cortical Ischemia: Bilateral CM-PF and Posterior Hypothalamic Targeting with Neurophysiological Validation

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William Omar Contreras López,[1] Fabián Piedimonte,[2] Juan Esteban Rosales,[1] Paula Alejandra Navarro González,[1] Nicolás Moreno Guerra.[1]

[1] International Neuromodulation Center NEMOD, Colombia.

[2] Fundación CENIT para la Investigación en Neurociencias. Argentina.

Corresponding author: William Omar Contreras López. email: wcontreras127@unab.edu.co

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Abstract

Introduction: Post-anoxic brain injury is a major cause of prolonged disorders of consciousness (DoC) and minimal functional recovery despite intensive rehabilitation. We report a case of advanced neuromodulation in a patient with chronic minimally conscious state (MCS) following global cortical ischemia secondary to cardiorespiratory arrest.

Clinical description: A 57-year-old female with a history of perioperative hypoxic-ischemic encephalopathy presented with persistent MCS for over 12 months. MRI demonstrated extensive ischemic damage involving bilateral occipital cortex, frontal lobes, and centrum semiovale. PET scan revealed generalized cortical hypometabolism. Long-term video-EEG telemetry showed preserved occipital alpha activity, indicating partial integrity of thalamocortical projections—a recognized predictor of recovery potential in selected candidates for DBS. Based on clinical and neurophysiological criteria, bilateral deep brain stimulation was proposed targeting two complementary neuroanatomical structures: Centromedian-Parafascicular (CM-Pf) complex of the thalamus, and Posterior hypothalamic area (PHyp).

Discussion: The synergistic combination of CM-Pf, to restore thalamocortical connectivity and frontoparietal networks activation implicated in consciousness, and PHyp to modulate arousal and active monoaminergic pathways, improving wakefulness, visual tracking, vocalization, and cortical excitability, has demonstrated sustained functional benefits in chronic MCS, including recovery of command-following, reduction of spasticity, and progress in communication. At microelectrode findings, PHyp confirmed neuronal activity consistent with the hypothalamic region. During intraoperative stimulation, BIS index increased from 36 to 95, accompanied by autonomic changes (blood pressure and heart rate modulation). CM-Pf revealed neurons with intermediate firing patterns, supporting accurate CM-Pf localization.

Conclusions: This case of Dual-target DBS involving CM-Pf and PHyp represents a feasible therapeutic strategy for refractory DoC, neurophysiological markers such as preserved alpha rhythms and tractographic validation are essential for

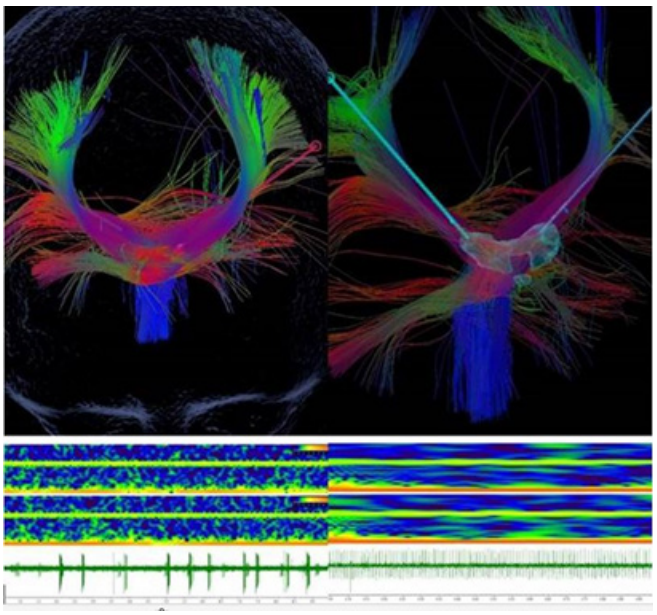

Figure 1. Combined visualization of structural connectivity and intraoperative electrophysiology during dual-target deep brain stimulation (DBS) for a disorder of consciousness after global cortical ischemia. Diffusion tensor imaging (DTI) tractography illustrates thalamocortical and hypothalamic projections (color-coded by orientation), confirming trajectories toward the centromedian–parafascicular complex (CM-Pf) and posterior hypothalamic area (PHyp). Corresponding local field potential (LFP) spectrograms and raw microelectrode recordings show low-frequency, beta, and gamma oscillations consistent with network reactivation and arousal modulation. This integrated approach validates network-level neuromodulation targeting both thalamic and hypothalamic substrates of consciousness.

patient selection and surgical planning. Integration of microrecording and neurophysiological monitoring enhances accuracy and may expand DBS indications beyond movement disorders. Further studies are needed to confirm long-term outcomes and refine stimulation paradigms for DoC.

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