

Intraoperative electrophysiology during deep brain surgeries in disorders of consciousness

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The efficacy on deep brain stimulation in disorders of consciousness (DC) is inconclusive. We investigated bilateral 30-Hz low-frequency stimulation designed to overdrive neuronal activity by dual pallido-thalamic targeting to promote conscious behavior in five patients. Five adult patients (mean age 38 years old) were included: one unresponsive-wakefulness-syndrome male (traumatic brain injury); and four patients in a minimally conscious state, one male (traumatic brain injury) and three females (two hemorrhagic strokes and one traumatic brain injury). Pallido-thalamic electrode targeting were performed under sevoflurane general anesthesia with recording of extracellular multi-unit neuronal activity and local field potential (LFP). These data were compared with five GPi DBS implantations (three males) for Parkinson's disease (n=4) or dystonia (59 years old) and three VIM DBS surgeries (two males) for Parkinson's disease (n=1) or essential tremor (40 years old).

The electrode implantation was realized after electrophysiological mapping using an intraoperative electrophysiological system for functional neurosurgery (MicroGuide Pro, Alpha Omega Eng., Israel). For each brain hemisphere, the mapping was performed using two exploration electrodes (Alpha Omega Eng.) steered by rigid guide tubes: one on the planned track and a second one on the parallel track located posteriorly at 2mm. The characteristics of our electrophysiological approach were as follow: systematic recordings of the spontaneous neuronal activity every 1 mm during 30 seconds along the distal 8.2 mm (min: 5; max: 13 mm) in the pallidum and the thalamus previously labelled and manually outlined on stereotactic MRI.

Spikes were encountered for 50 out of 130 recordings in the pallidum (38.46%) and for 43 out of 185 (23.24%) in the thalamus of patients with disorders of consciousness. Concerning motor disease (MD) patients implanted under general anesthesia, spikes were found in 52 out of 150 recordings in the pallidum (34.66%) and for 54 out of 82 (65.85%) in the thalamus. Mean firing rate of neurons in the pallidum was 9.84 +/-8.71 Hz and 11.95 +/-10.31 Hz during surgery for patients with DC and MD respectively. Concerning Thalamus, mean firing rate was 3.78 +/-4.87 Hz versus 2.25 +/-2.15 Hz (DC vs MD).

Percentage of raw power spectral density of LFP was similar in GPi for patients with DC and MD. Delta (47.8%), Theta (19.5%) and Alpha (17.0%) bands were preponderant for DC, while Delta (37.2%), Alpha (29.1%) and Beta (17.0%) range were powerful for MD patients.

Pallidal neuronal activity is similar for patients under general anesthesia suffering from DC or MD. Differences were encountered for Thalamus: higher 7-30Hz frequency power was encountered for patients with MD and higher low (<7Hz) and high (>30Hz) band power was observed for DC.

Thalamic neuronal activity differs between MD and DC patients. Few records have been obtained and published for patients with impaired consciousness. These results should be considered with caution given the small number of patients in the study.

This clinical trial (NCT01718249) was funded by the Fondation de l'Avenir (ET1-615 2011; "Deroche Legacy" Grant BO4-001), the University Hospital of Clermont-Ferrand, the Centre Jean Perrin and Medtronic France.

DBS-Post-coma study group and clinical research protocol are detailed here: <https://onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1002%2Facn3.648&file=acn3648-sup-0001-Supinfo.docx>

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Topic: neurophysiology

Format: ePoster

Keywords: electrophysiology, deep brain stimulation, disorders of consciousness