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Localisation Of The Subthalamic Nucleus In Parkinson's Disease with Neural Beta and Gamma Activity of Local Field Potentials

Daphne Zwartjes, MSc, TU, Enschede, Netherlands; Rick Schuurman, Academic Medical Center Amsterdam, Amsterdam, Netherlands; Rens Verhagen, MSc, Amsterdam, Netherlands; Ciska Heida, PhD, TU, Enschede, Netherlands; Fiorella Contarino, MD, PhD, Amsterdam, Netherlands; Rob de Bie, MD, PhD, Amsterdam, Netherlands; Pepijn van den Munckhof, MD, PhD, Amsterdam, Netherlands; Hubert Martens, PhD, Sapiens, Eindhoven, Netherlands; Peter Veltink, PhD, TU, Enschede, Netherlands; Lo Bour, Amsterdam, Netherlands

Introduction: To refine the MRI-based target during DBS surgery, microelectrode recordings (MER) are often performed to detect target-specific single unit activity. This requires additional recording time and increases the risk for haemorrhage. In the future it may therefore be relevant to be able to determine the implantable lead's position based on local field potential (LFP) recordings from the lead itself which reflect activity of a larger neural population. This study aims to evaluate the nature of oscillatory activity in the subthalamic nucleus (STN) by means of intraoperative LFP-recordings, its relationship with microelectrode recordings and its potential use to locate the STN and its sensorimotor sub-area in patients with Parkinson's disease during deep brain stimulation (DBS) surgery.
Methods: 25 patients with Parkinson's disease are included in this study. MER and LFPs are recorded every 0.5 mm from multiple microelectrodes during DBS surgery in 48 STNs. A novel optimization approach to map the measurement points on an atlas STN based on the MER properties is used to enable a detailed spatial representation of these points. Power and coherence in different LFP frequencies at all points are assessed in reference to the point's location inside or outside the STN and its sensorimotor sub-area.
Results: Coherence between LFPs and the envelope of spiking activity significantly increases when entering the STN. There is also a pronounced increase in the LFP power in the gamma band, which persists throughout the entire STN in 100% of the cases. In 70% of the cases LFPs have a significantly higher power in the high beta frequency band in the sensorimotor STN, defined by the mapping algorithm, compared to the non-sensorimotor STN.
Conclusions: LFP gamma oscillations provide a useful tool for locating the STN intraoperatively and LFP beta oscillations can become useful to discriminate the sensorimotor area within the STN.