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Novel insights into the origin of subthalamic beta oscillations in Parkinson's disease

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Introduction: Neuronal subthalamic (STN) activity in Parkinson's disease (PD) is thought to be characterized by an excessive rhythm in beta-band frequency range (12-35 Hz), which is normalized by levodopa [1-2]. The aim of our study was to explore the origin of beta oscillations, by assessing possible changes of subthalamic LFPs in different moments during Deep Brain Stimulation (DBS) surgery [2]. That is of key importance because the beta rhythm is now considered the most reliable electrophysiological marker for guiding novel adaptive DBS approaches.

Objective: We started from two alternative hypotheses, that the LFPs of the STN play a central role in the "feed-forward" organization of movements or that β-band oscillations represent a mere epiphenomenon due to gamma-motoneuronal over-activity reflecting the patient's status.

Methods: STN signals were recorded in four patients (2 men, 2 women) in three different moments during DBS implantation: before sedation (T0), under the effect of both Propofol (2-3 microg/ml) and rocuronium (30 mg) (T1) and during Propofol alone (2-3 microg/ml) (T2). LFPs were analyzed in terms of both linear and non-linear analyses: power spectral density, sample entropy and multiscale entropy, as well as burst analysis.

Results: High values of Sample entropy have been observed at the level of the left posterior region in T2 (0.7045) compared to T1 (0.6375); even more effective was the burst analysis which shows significant increase in terms of mean amplitude ($p = 0.017$) on the same.

Conclusions: Whether there is an involvement of the peripheral system, or gamma-motoneurons, in the modulation of the hyper-synchronized β power is still a matter of debate, our work could highlight novel insights into the origin of the beta rhythm, possibly suggesting that these oscillations arise away from the basal ganglia network.

References:

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