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Chronic adaptive deep brain stimulation for PD: clinical outcomes and programming strategies.

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Deep brain stimulation (DBS) for Parkinson's disease (PD) classically operates by continuously stimulating basal ganglia structures with constant parameters, regardless of the patient's clinical state. While highly effective, this approach carries the risk of transient episodes of over- or understimulation. To address this, adaptive deep brain stimulation (aDBS) has been developed over the past ten to fifteen years, which adjusts stimulation amplitude based on neurophysiological feedback. This year, aDBS based on subthalamic beta power has been commercialized and is beginning to enter clinical practice. However, real-world outcomes have been scarcely reported, and programming strategies remain elusive.

In this study, we programmed eight people with PD who already had optimized continuous DBS (cDBS). Using a dual-threshold algorithm, we compared two weeks of cDBS with two weeks of aDBS while patients completed brief symptom surveys at home six times per day. aDBS produced a significant group-level improvement in overall well-being (mean 5.92 to 6.73; $p = 0.007$) and a trend toward better general movement (5.47 to 6.20; $p = 0.058$). Individually, overall well-being improved in all eight patients and reached statistical significance in three; general movement improved in five of seven, with three significant. After the trial phase, six of eight patients chose to remain on aDBS.

In clinical practice, we found that aDBS required multiple programming visits before a satisfactory configuration was achieved (4–13 visits), creating a significant additional resource burden in an already highly specialized tertiary center. Furthermore, we identified movement-related artefacts, long-term beta drifts spanning several days, and sensing-incompatible stimulation configurations as potential challenges in aDBS programming.

To foster clinical adoption, we proposed a practical three-step workflow based on our experience from this study. First, during a preparatory phase, at-home recordings of beta-band power provide a foundation for setting up the aDBS algorithm. Second, aDBS amplitude limits are set according to clinical needs, and beta power thresholds are derived from the beta power distributions obtained during the preparatory phase. Third, during follow-up visits, thresholds are fine-tuned and stimulation limits adjusted to prevent maladaptation. In sum, this real-world case series shows that beta-guided aDBS can deliver meaningful day-to-day benefits for selected patients who remain symptomatic on optimized cDBS and provides a practical clinical workflow for implementing aDBS.

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Johannes Busch is a medical doctor in the Kühn lab. His main research interest is invasive human neurophysiology in movement disorders and adaptive deep brain stimulation.

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Andrea Kühn is the director of the Movement Disorders and Neuromodulation Unit at Charité Berlin and the ReTune Spokesperson. Her research on basal ganglia electrophysiology has majorly contributed to the understanding of the pathophysiology of movement disorders and the mechanisms of action of DBS.

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