Title: Longitudinal Scalp-EEG Spectral Analysis of ANT-DBS in Epilepsy

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Abstract
Deep brain stimulation of the anterior nucleus of the thalamus (ANT-DBS) is used for drug-resistant epilepsy, but its cortical EEG effects—and their stability over time—are not well established. We asked whether scalp-EEG shows a reproducible "fingerprint" during stimulation that could serve as a biomarker. We analyzed five patients recorded twice one year apart (2018 and 2019). Each 10-minute session included ~100 cycles of 1-s DBS ON and 5-s OFF with 64-channel EEG Sampled at 2 kHz. After standard cleaning and 1–80 Hz band-pass filtering, we computed multitaper power spectral densities and time-frequency representations for the ON window and five consecutive 1-s OFF windows. We quantified log-power differences ($\Delta = ON - OFF_k$) in canonical bands and tested contrasts using Welch t-tests with FDR correction. Across patients and years, gamma (30–70 Hz) increased during stimulation (≈+1.3 dB, FDR-significant in 46/50 high-frequency contrasts), while delta (1–4 Hz) decreased (≈−1.4 dB). The high–low frequency contrast remained ~+2.2 dB across both years, indicating strong longitudinal reproducibility at group and individual levels. These findings define a stable spectral signature of ANT-DBS—fast-band enhancement with slow-band suppression—that is observable with routine scalp-EEG and consistent across sessions a year apart. Such a robust pattern is a practical candidate biomarker to support adaptive DBS programming without additional hardware and may facilitate cross-disciplinary collaboration on closed-loop neuromodulation strategies.