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Purpose: The development of wearable, unobtrusive EEG equipment opens up for longer recordings than ever before. Ultra long-term monitoring of brainwaves in a patient's everyday life allows us to obtain a circadian model for the typical electrographical patterns of the brain, which in turn allows us to detect daily patterns that deviate from the norm.
Method: 6 healthy adults, were monitored continuously with a subcutaneous EEG recording system for at least 40 days. The EEG signal for the entire period was filtered into traditional frequency bands (δ: 0-4 Hz, θ: 4-8 Hz, α: 8-13 Hz, β_{low}: 13-20 Hz, and β_{high}: 20-30 Hz), and the power was analyzed.
Results: The power features showed circadian trends indicating states of vigilance and sleep that were remarkably stable across the entire recording for all volunteers. Especially the power in the δ-range showed periodic increases and decreases during sleep with a period of approximately 1.6 hours with high predictability. The amplitude of the periodic power increase was highest in the beginning of the night and decreased towards the morning.
Conclusion: A clinical study with temporal lope epilepsy patients has started, where the patients' brainwaves are recorded continuously and ambulatory for approximately 3 months. With the circadian model it is possible to quantify how seizures, which are known to disrupt the normal sleep pattern, affect the otherwise statistically stable sleep trends in the EEG, and reveal any possible impact of interictal epileptiform discharges on the sleep pattern as well. In the future, features from ultra long-term EEG will likely play a significant role in optimization of diagnostics and treatment in epilepsy and a range of diseases with circadian patterns.