

Slow-wave activity surrounding stage N2 K-complexes and daytime function measured by psychomotor vigilance test in obstructive sleep apnea

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Abstract

Study Objective

To better understand the inter-individual differences in neurobehavioral impairment in obstructive sleep apnea (OSA) and its treatment with continuous positive airway pressure (CPAP), we examined how changes in sleep electroencephalography (EEG) slow waves were associated with next-day psychomotor vigilance test (PVT) performance.

Methods

Data from 28 OSA subjects (Apnea–Hypopnea Index with 3% desaturation and/or with an associated arousal [AHI3A] > 15/hour; AHI3A = sum of all apneas and hypopneas with 3% O₂ desaturation and/or an EEG arousal, divided by total sleep time [TST]), who underwent three full in-lab nocturnal polysomnographies (NPSGs: chronic OSA, CPAP-treated OSA, and acute OSA), and 19 healthy sleepers were assessed. Four 20-minute PVTs were performed after each NPSG along with subjective and objective assessment of sleepiness. Three EEG metrics were calculated: K-complex (KC) Density (#/minute of N2 sleep), change in slow-wave activity in 1-second envelopes surrounding KCs (Δ SWAK), and relative frontal slow-wave activity during non-rapid eye movement (NREM) (%SWA).

Results

CPAP treatment of OSA resulted in a decrease in KC Density (chronic: 3.9 ± 2.2 vs. treated: 2.7 ± 1.1 ; $p < 0.01$; mean \pm SD) and an increase in Δ SWAK (chronic: 2.6 ± 2.3 vs. treated: 4.1 ± 2.4 ; $p < 0.01$) and %SWA (chronic: 20.9 ± 8.8 vs. treated: 26.6 ± 8.6 ; $p < 0.001$). Cross-sectionally, lower Δ SWAK values were associated with higher PVT Lapses (chronic: $\rho = -0.55$, $p < 0.01$; acute: $\rho = -0.46$, $p = 0.03$). Longitudinally, improvement in PVT Lapses with CPAP was associated with an increase in Δ SWAK (chronic to treated: $\rho = -0.48$, $p = 0.02$; acute to treated: $\rho = -0.5$, $p = 0.03$). In contrast, OSA severity or global sleep quality metrics such as arousal index, NREM, REM, or TST were inconsistently associated with PVT Lapses.

Conclusion

Changes in EEG slow waves, in particular Δ SWAK, explain inter-individual differences in PVT performance better than conventional NPSG metrics, suggesting that Δ SWAK is a night-time correlate of next-day vigilance in OSA.

OSA, OSA–PAP therapy, slow-wave sleep, sleep-disordered breathing, EEG spectral analysis, K-complex, excessive daytime sleepiness, psychomotor vigilance test

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