Perioperative Electroencephalogram Spectral Dynamics Related to Postoperative Delirium in Older Patients

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Background: Intraoperative electroencephalography (EEG) signatures related to the development of postoperative delirium (POD) in older patients are frequently studied. However, a broad analysis of the EEG dynamics including preoperative, postinduction, intraoperative and postoperative scenarios and its correlation to POD development is still lacking. We explored the relationship between perioperative EEG spectra-derived parameters and POD development, aiming to ascertain the diagnostic utility of these parameters to detect patients developing POD.

Methods: Patients aged ≥65 years undergoing elective surgeries that were expected to last more than 60 minutes were included in this prospective, observational single center study (Biomarker Development for Postoperative Cognitive Impairment [BioCog] study). Frontal EEGs were recorded, starting before induction of anesthesia and lasting until recovery of consciousness. EEG data were analyzed based on raw EEG files and downloaded excel data files. We performed multitaper spectral analyses of relevant EEG epochs and further used multitaper spectral estimate to calculate a corresponding spectral parameter. POD assessments were performed twice daily up to the seventh postoperative day. Our primary aim was to analyze the relation between the perioperative spectral edge frequency (SEF) and the development of POD.

Results: Of the 237 included patients, 41 (17%) patients developed POD. The preoperative EEG in POD patients was associated with lower values in both SEF (POD 13.1 ± 4.6 Hz versus no postoperative delirium [NoPOD] 17.4 ± 6.9 Hz; P = .002) and corresponding γ-band power (POD -24.33 ± 2.8 dB versus NoPOD -17.9 ± 4.81 dB), as well as reduced postinduction absolute α-band power (POD -7.37 ± 4.52 dB versus NoPOD -5 ± 5.03 dB). The ratio of SEF from the preoperative to postinduction state (SEF ratio) was ~1 in POD patients, whereas NoPOD patients showed a SEF ratio >1, thus indicating a slowing of EEG with loss of unconscious. Preoperative SEF, preoperative γ-band power, and SEF ratio were independently associated with POD (P = .025; odds ratio [OR] = 0.892, 95% confidence interval [CI], 0.808-0.986; P = .029; OR = 0.568, 95% CI, 0.342-0.944; and P = .009; OR = 0.108, 95% CI, 0.021-0.568, respectively).

Conclusions: Lower preoperative SEF, absence of slowing in EEG while transitioning from preoperative state to unconscious state, and lower EEG power in relevant frequency bands in both these states are related to POD development. These findings may suggest an underlying pathophysiology and might be used as EEG-based marker for early identification of patients at risk to develop POD.