High Frequency Signals in Frontal Cortex at Loss of Consciousness

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Background/Introduction: Brain oscillations have rarely been studied at frequencies beyond 200 Hz, and it remains unknown what the highest frequency of brain bioelectric activity is. We used the volatile anesthetic, isoflurane, to depress activity at behavioral endpoints of loss of righting reflex (LORR) and loss tail clamp responses (LOTC). These endpoints provide surrogate measures of loss of consciousness (LORR) and surgical anesthesia (LOTC) in rats. We recorded signals from DC to 20 KHz; extending analysis of oscillatory cortical activity well beyond traditional ranges.

Methods: Following IRB approval, local field potentials were recorded from layer 2/3 of frontal cortex in rats using chronically implanted electrodes. Rats were placed in an air-tight chamber with a controlled atmosphere of room air that was slowly replaced with increasing concentrations of isoflurane in oxygen, delivered from a calibrated vaporizer. Body temperature was maintained using a heat lamp. Animal behavior was carefully monitored to determine LORR and LOTC responses. Rats recovered following each experiment after replacing isoflurane with room air.

Results: Isoflurane produced a characteristic profile of effects, consistent with previous reports. At LORR high amplitude slow wave activity was evident that transitioned to a burst suppression pattern at LOTC. Spectral analysis revealed that increased slow wave activity was accompanied by decreased higher frequencies in the gamma and high-gamma bands, and extending beyond 1.0 KHz at LORR. This high frequency activity was not due to multiunit action potential discharge, nor to harmonics from lower frequencies.

Conclusions: Isoflurane depressed high frequency cortical activity well beyond the traditional EEG frequency range of 200 Hz. Future research should investigate brain processes that are associated with this very high frequency brain activity, between 500 to > 1000 Hz.

Key words: Anesthetic, EEG, Cortex, Unconscious, High-gamma, Ultrahigh Frequency.