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Localization of the epileptogenic zone: What is the role of wide-band frequencies analysis?

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Aim: The aim of the study is to identify the predominant ictal onset frequencies with wide spectrum EEG frequency analysis.

Method: 14 patients with medically refractory partial epilepsy undergoing intracranial macroelectrode monitoring (8 depth electrodes, 6 subdural grids) were analyzed. Digital EEG data was sampled at 2 kHz at various intervals. Multiband frequency and power analysis were performed to characterize the predominating frequency during the interictal, pre-ictal, ictal, and postictal periods.

Result: 51 seizures, 19 seizures collected from subdural grid and 32 from depth electrodes were analyzed. Power spectrogram of frequency band between 0-100 Hz demonstrated a significant increase of 10-30 Hz frequencies preceding the increase of 30-100 Hz frequencies by 3 seconds before propagation in 38 seizures from 10 patients. In each case, the ictal onset was localized to one to two contacts. Focal surgical resections were performed in the areas correlated to the synchronization of these alpha-beta frequencies and HFO prior to and during the patients' clinical seizures. These 10 patients have seizure-free outcomes confirming the localization. In contrast, the alpha-beta frequencies synchronization was not seen in four patients (13 seizures) who did not become seizure-free post-operatively.

Conclusion: Previous studies of HFO from intracranial EEG recordings consistently show the frequencies at ictal onset above gamma range. However, most of these studies utilize microelectrodes and/or single neuron recording techniques. In our study, HFO were preceded by lower frequency activity and the presence of the lower frequencies synchronization correlated with post-operative seizure freedom. HFO may not be the first ictal manifestation in some cases and lower frequency ictal frequencies should not be overlooked. Larger studies are underway.

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