A Simple Statistical Method for the Automatic Detection of High Frequency Oscillations in Human Intracranial EEG

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Rationale

Visual identification of high frequency oscillations (HFOs) is time consuming and subject to bias, therefore, development of automatic detection algorithms is critical. Existing algorithms are promising, but their accuracy depends on complex optimization of multiple parameters, and false positives remain a challenge. We have developed an HFO detection algorithm that relies on only one parameter, enabling it to be applied consistently and broadly across centers and datasets.

Methods

The algorithm identifies events whose amplitudes are statistically different from the background activity. It has one tunable parameter related to the sensitivity/specificity of event detection. We first estimate the background probability distribution, and the characteristics of this distribution are used to iteratively calculate an optimal amplitude threshold. We tested the algorithm on intracranial EEG data from 19 human subjects (from Zelmann et al. 2012), comparing the results to four previously published detectors with visual detection as the gold standard.

Results

The detector achieved 99% sensitivity for the detection of ripples, with 1% false positive rate and 59% false detection rate, demonstrating improvement over published detectors. Alternatively, when prioritizing minimal false detections, the algorithm had 88% sensitivity, 9% false positive rate, and 18% false detection rate. This may be preferable in situations where a large amount of data makes visual rejection of false positives unrealistic.

Conclusion

The proposed algorithm has only one adjustable parameter and demonstrates improved performance. Overall, it reduces the subjectivity and inconsistency of HFO detection as a tool for the characterization of epileptic activity.