Functional significance of epileptogenic fast activity: a study of motor cortex seizures.

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Rationale:
High-frequency activities (HFAs) in human epilepsies have been subject to many studies for a decade. Most of them have been dedicated to interictal high-frequency oscillations (HFOs) with emphasis on their correlation with the epileptogenic zone localization. Few of them have addressed the question of HFAs as an ictal pattern and even less have analyzed their relation to clinical semiology. The present study has been designed to analyze the electrophysiological effect of a narrow-band fast activity onto the efferent volleys of the motor cortex during locally generated epileptic seizures.
Method:
High-frequency activities (HFAs) in human epilepsies have been subject to many studies for a decade. Most of them have been dedicated to interictal high-frequency oscillations (HFOs) with emphasis on their correlation with the epileptogenic zone localization. Few of them have addressed the question of HFAs as an ictal pattern and even less have analyzed their relation to clinical semiology. The present study has been designed to analyze the electrophysiological effect of a narrow-band fast activity onto the efferent volleys of the motor cortex during locally generated epileptic seizures. Results5 patients (3 male and 2 females, mean age 22.4 years old) with 157 analyzable seizures fulfilled the selection criteria. Patient #1 did not present any clinical motor signs during HFA. The first motor sign corresponded to the onset of beta rhythm sustained activity (< 30 Hz). The same was observed in patient #2: the earliest clonic movement occurred simultaneously with a subsequent beta activity. Patient #3 was a child who was crying due to inability to move her left hand in the beginning of her seizures. Her arm was actually atonic as long as the motor cortex discharge kept in HFA range. Clonic movements appeared in the same arm when HFA vanished and alpha/beta activity emerged. Patient #4 presented with multiple clusters of brief atonic and tonic facial motor signs. Two distinct frequency patterns correlated with the two states. A high-gamma activity was associated to the atonic facial seizures and a beta/low gamma activity to the facial tonic seizures. An ictal rhythm of low gamma/beta activity (18-35 Hz) without any HFA correlated with tonic left arm and shoulder motor signs in patient #5. A quantitative analysis using time-frequency plots confirmed an epileptogenic zone fingerprint in all patients. Latency of motor sign onset with respect to the onset and duration of fast activity was analyzed. A significant correlation (with an uncorrected p-value of) between the two measures was observed, indicating that the longer the HFA the longer the latency of motor signs.
Conclusion:
Epileptogenic frequency patterns have a pathophysiological significance. This study on primary motor cortex seizures allowed a direct measure of the cortical output. HFAs were showed to have an opposite functional effect according to their frequency range. High gamma fast activity was associated with an inhibition of the motor cortex output. Tonic ictal discharges in the beta/low gamma range were the frequency pattern associated with tonic motor signs.
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