Entropy assessment of EEG recordings and its application in temporal lobe epileptic patients

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Non-linear dynamics have been shown to be important in describing a large number of complex physiological systems and complex time series such as EEG that can be characterized more adequately by non-linear dynamical analysis than by linear time series analyses (Zhang & Turner, 2001). Recently, we have utilized cross-sample entropy (cross-SampEn) to measure the asynchrony of two distinct time series generated from cardiovascular system (Johns et al. 2001; Yang et al. 2002). In this study we introduced SampEn measurement for estimating complexity of short EEG time series collected from both healthy subjects and temporal lobe epilepsy (TLE) patients.

A total of eight channels of EEG signals, collected from eight patients and 10 healthy subjects, were analysed using algorithms for SampEn. Two sliding windows, 1 s window and 4 s window, and five different filters levels \( r \) were used. All data collection was performed using International 10/20 Systems connected to the scalp and a continuous recording of 16 channels was obtained using clinical equipment (Holter, Modeling MR95 Dynamical EEG Machine, Denmark). A reference electrode was attached to the subject’s ear in all cases. The signals were sampled at 256 Hz with 12-bit resolution. Data, means ± S.E.M. or means ± S.D., were compared using Student’s \( t \) test with significance taken at \( P < 0.05 \). Local ethical approval was obtained for the study.

The EEG SampEn in TLE patients (from 0.69 ± 0.05 to 0.92 ± 0.04 for 1 s window and from 0.80 ± 0.07 to 1.10 ± 0.05 for 4 s window) was significantly \((P < 0.05 \) to 0.001\) lower compared to that in healthy subjects (from 0.91 ± 0.04 to 1.03 ± 0.03 for 1 s window and from 1.14 ± 0.06 to 1.46 ± 0.06 for 4 s window). The degree of complexity in the epileptic focus hemisphere \((0.87 ± 0.03 \) in T3/T4 for 1 s window\) was not significantly different from that in the non-focus hemisphere in patients \((0.91 ± 0.04)\). Moreover, the small sliding window may provide more details associated with the seizure. The filter level \( r \) should not be smaller than 0.15 % S.D. for the 1 s window or 10 % S.D. for the 4 s window.

The results have demonstrated that entropy measurement could be an alternative non-linear approach for analysing short-term EEG signals. The lower values observed in the complexity of the EEG signal for TLE patients provide preliminary support for the notion that the complex non-linear nature of brain electrical activity may be the result of isolation or impairment of the neural information transmission within the brain.


All procedures accord with current local guidelines and the Declaration of Helsinki.

All presenting authors must attend the relevant Poster Discussion and Approval Session.