

# 一种改进的近似熵——样品熵及其在颞叶癫痫患者脑电信号分析中的应用

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本文采用了近似熵 ( ) 和它的改进算法, 即样品熵 ( ) 分析了8位颞叶癫痫患者和10位健康人员的短程脑电信号。在计算过程中使用了两种滑动窗口和5个不同的过滤标准 $r$ 。结果显示颞叶癫痫患者组脑电信号的熵值显著低于健康组, 而且患者癫痫病灶脑半球的复杂度远远大于非癫痫病灶半脑。小的滑动窗口能更多地反映与癫痫发作相关的细节。对于1秒的滑动窗口, 过滤标准 $r$ 不能小于时间序列标准差的0.15%; 而对于4秒的滑动窗口, 则过滤标准 $r$ 不能小于时间序列标准差的10%。研究结果表明, 在短程脑电信号的非线性分析中, 样品熵是一种比近似熵更为可靠的非线性分析方法。颞叶癫痫患者脑电信号的熵值低于健康人员, 这可能表明脑电活动的非线性程度的降低是由于神经信号在大脑内的传递受到了阻碍或者损坏, 使得神经信号成了相对孤立的信息源。

## Complexity measurements of Electroencephalograph (EEG) recordings using sample entropy algorithm in patients with temporal lobe epilepsy

We investigated the potential application of entropy measurements to analyze short-term EEG traces of patients with temporal lobe epilepsy (TLE). Total eight channels EEG signals, collected from 8 patients and 10 healthy subjects, were analyzed by both algorithms of the approximate entropy (ApEn) and sample entropy (SampEn). Two sliding windows and 5 different filters levels  $r$  were used and discussed. The entropies of EEG were significantly lower in patients with TLE compared to that in healthy one. The degree of complexity in the epileptic focus hemisphere was lower than in the non-focus hemisphere in patients. Small sliding window may provide more details associated with the seizure. The filter level  $r$  must not be smaller than 0.15% SD for 1s-window whilst it must not be smaller than 10% SD for 4s-window. The results of this study have demonstrated that entropy measurements could be alternative nonlinear approaches for analyzing short-term EEG signals. The observed lower values in the complexity of the EEG signal for patients with TLE provide preliminary support for the notion that the complex nonlinear nature of brain electrical activity may be the result of isolation or impairment of the neural information transmission within the brain.

Key words: Temporal lobe epilepsy, EEG, approximate entropy, sample entropy

### 关键词

颞叶癫痫, 脑电图, 近似熵, 样品熵 (Temporal lobe epilepsy, EEG, approximate entropy, sample entropy)