Digital spiral analysis for objective assessment of fine motor timing variability in Parkinson’s disease

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OBJECTIVE

To develop a method for objective assessment of fine motor timing variability with Parkinson’s disease (PD) patients, using digital spiral data gathered by a touch screen device.

BACKGROUND

A retrospective analysis was conducted on data from 105 subjects including 65 patients with advanced PD (group A), 15 intermediate patients experiencing motor fluctuations (group I), 15 early stage patients (group S), and 10 healthy elderly subjects (HE) were examined [1].

RESULTS

When comparing mean spiral scores between the four subject groups, the APEN scores were different between HE subjects and three patient groups (P=0.062 for group with 9.9% mean value difference, P=0.089 for group with 30.2%, and P=0.019 for A group with 44.1%). However, there were no significant differences in mean scores of the other two methods, except for the WAV between the HE and A groups (P=0.001).

WAV and SDDV were highly and significantly correlated to each other with a coefficient of 0.69. However, APEN was not correlated to neither WAV nor SDDV with coefficients of 0.11 and 0.12, respectively.

Test-retest reliability coefficients of the three scores were as follows: APEN (0.9), WAV(0.83) and SDDV (0.55).

In addition, two more methods were applied on digital spiral data and their scores were used in subsequent analysis. The first method was based on Digital-Wavelet Transform and Principal Component Analysis and generated a score representing spiral drawing impairment (SDDV). The score generated by this method is hence denoted SDDV.

METHODS

The raw spiral data were processed with three data processing methods. To quantify motor timing variability during spiral drawing tasks Approximate Entropy (APEN) and standard deviation of frequency filtered drawing velocity [4] were applied on digitised spiral data. APEN is designed to capture the irregularity or complexity in time series [2]. APEN requires determination of two parameters, namely, the window size and similarity measure. In our work and after experimentation, window size was set to 4 and similarity measure to 0.2 (20% of the standard deviation of the time series). The final score obtained by APEN was normalized by total drawing completion time and used in subsequent analysis. The score generated by this method is hence denoted APEN.

CONCLUSIONS

The result show that the digital spiral analysis-based objective APEN measure is able to significantly differentiate the healthy subjects from patients at advanced level.

In contrast to the other two methods (WAV and SDDV) that are designed to quantify dyskinesia (overmedications), this method can be useful for characterizing Off symptoms in PD.

The APEN was not correlated to none of the other two methods indicating that its measure is different construct of upper limb motor function in PD patients than WAV and SDDV.

The research had a better test-retest reliability indicating that it is more stable and consistent over time than WAV and SDDV.

REFERENCES


