Spiral drawing during self-rated dyskinesia is more impaired than during self-rated off

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Background

A mobile device test battery, consisting of a patient diary collection section with disease-related questions and a fine motor test section (including spiral drawing tasks), was used by 65 patients with advanced Parkinson’s disease (PD) (treated with intraduodenal levodopa/carbidopa gel infusion, Duodopa®, or candidates for this treatment) on 10439 test occasions in their home environments [1]. On each occasion, patients traced three pre-drawn Archimedes spirals using an ergonomic stylus (Fig 1a) and self-assessed their motor function on a global Treatment Response Scale (TRS) [2] ranging from -3 = very ‘off’ to 0 = ‘on’ to +3 = very dyskinetic, as shown in Table 1. The spirals were processed by a computer-based method that generates a “spiral score” representing the PD-related drawing impairment [3]. The scale for the score was based on a modified Bain & Findley rating scale [4] in the range from 0 = no impairment to 5 = moderate impairment to 10 = extremely severe impairment (Fig 1b).

Objective

To analyze the test battery data for the purpose to find differences in spiral drawing performance of PD patients in relation to their self-assessments of motor function.

Methods

Three motor states were used in the analysis; OFF state (including moderate and very ‘off’), ON state (‘on’) and a dyskinetic (DYS) state (moderate and very dyskinetic). In order to avoid the problem of multiple test occasions per patient, 200 random samples of single test occasions per patient were drawn. One-way analysis of variance, ANOVA, test followed by Tukey multiple comparisons test was used to test if mean values of spiral test parameters, i.e. the spiral score and drawing completion times (in seconds), were different among the three motor states. Statistical significance was set at $p<0.05$. To investigate changes in the spiral score over the time-of-day test sessions for the three motor states, plots of statistical summaries were inspected.

Figure 1.

Spiral tracing in the mobile device test battery (a) and examples of spiral drawings with drawing impairments scored as 1 (left), 5 (middle) and 10 (right) (b).

Results

The mean spiral score differed significantly across the three self-assessed motor states ($p<0.001$, ANOVA test). Tukey post-hoc comparisons indicate that the mean spiral score (mean $\pm$ SD; [95% CI for mean]) in DYS state (5.2 ± 1.8 ; [5.12, 5.28]) was higher than the mean spiral score in OFF (4.3 ± 1.7 ; [4.22, 4.37]) and ON (4.2 ± 1.7 ; [4.17, 4.29]) states (Fig 2). The mean spiral score was also significantly different among individual TRS values of slightly ‘off’ (4.02 ± 1.63), ‘on’ (4.07 ± 1.65) and slightly ‘dyskinetic’ (4.6 ± 1.71), ($p<0.001$). There were no differences in drawing completion times among the three motor states ($p=0.509$). In the OFF and ON states, patients drew slightly more impaired spirals in the afternoon whereas in the DYS state the spiral drawing performance was more impaired in the morning (Fig 3).

Table 1.

Answer alternatives for self-assessed motor state question.

TRS Value	Description
-3	Very off
-2	Moderately off
-1	Slightly off
0	On
1	Slightly dyskinetic
2	Moderately dyskinetic
3	Very dyskinetic

Figure 2.

Mean spiral score for each self-assessed motor state. Standard error bars are shown. For the spiral score, high value represents severe drawing impairment. NS, not significant. **, $p<0.005$ by ANOVA test.

Conclusions

It was found that when patients considered themselves as being dyskinetic spiral drawing was more impaired (nearly one unit change in a 0-10 scale) compared to when they considered themselves as being ‘off’ and ‘on’. The spiral drawing at patients that self-assessed their motor state as dyskinetic was slightly more impaired in the morning hours, between 8 and 12 o’clock, a situation possibly caused by the morning dose effect.

Figure 3.

Summary plots of spiral score per self-assessed motor state and time-of-day test session. Panel variable: self-assessed motor state. Symbols represent mean values and error bars one standard error of the mean. For the spiral score, high value represents severe drawing impairment. Number of test occasions during each time-of-day test session are indicated.

References

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