Automated Parkinson’s Disease Motor Assessment for Clinical and Ambulatory Monitoring

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Introduction

The current standard for evaluating motor impairment associated with Parkinson’s disease (PD) is the Unified Parkinson’s Disease Rating Scale (UPDRS), a qualitative assessment completed during an office visit. However, interpretation of a single examination is limited, particularly in patients with motor fluctuations. Therefore, periodic, objective symptom monitoring may aid in evaluating the efficacy of treatment protocols and improve overall patient management.

Kinesia System

Kinesia™ (CleveMed) is a user-worn, compact wireless system that uses accelerometers and gyroscopes to monitor three-dimensional motion (Figure 1). The software includes an automated motor assessment, which guides patients through several motor tasks that are part of the UPDRS motor assessment (Figures 2 and 3). In a pilot study involving 60 PD subjects, algorithms were developed for objectively rating motor symptoms. In order to expand upon and further validate the scoring algorithms, a multi-center clinical study involving 150 subjects at three clinical sites was implemented.

Clinical Results

Subjects wore the Kinesia system on the affected hand and underwent automated motor assessment (Figure 2) for several tasks (Figure 3). Subjects were videotaped for subsequent UPDRS scoring by movement disorder neurologists at three clinical test sites. Quantitative variables were extracted from the recorded motion data and correlated with clinical scores to develop a linear model for rating motor symptoms.

Clinical Results

In order to test how well our model generalizes, a “one left out” analysis was performed. For this analysis, a linear regression model was developed using all but one data point. The regression model was then used to predict the single data point that was left out. The analysis was repeated leaving each data point out once and the average root-mean-square (RMS) errors between the clinician UPDRS scores and the predicted scores were calculated. Results for tremor are shown in Figure 4.

Conclusions

The Kinesia motor assessment provides objective PD symptom scoring both in the clinic and at home. The home assessment allows for more continuous monitoring, which enables the capture of motor fluctuations that can occur throughout the day in response to medication. This increased temporal resolution may lead to the development of novel treatment options and help clinicians better prescribe and adjust therapies.

This work was supported by NIH, NINDS, 2-R44-NS043816-04