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Quantification of gait analysis of Parkinson's patients with the KLEB-footpad: a proof of principle study

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Abstract

The aim of this study is to explore the potential of the KLEB-footpad to objectively monitor Parkinson's disease and aid in diagnosis. Pressure sensitive footpads were used to quantify the steptime, hind- and forefoot delay and dominance (left/right and fore/hindfoot). The severe Parkinson's patient showed largest step time with the highest variance (1.86 ± 0.026), the least heel strike and highest intra variance (0.28 ± 2.8^{-3}). The mild Parkinson's patient showed a dominance in right forefoot.
Indicative parameters for Parkinson's revealed to be stance time, mean delay between hind- and forefoot and its variance. Larger control and Parkinson's populations should be researched to confirm that the KLEB-footpad and researched parameters are effective in the quantification of Parkinson's disease.

Monitoring the pro-/supination movement for quantifying the level of bradykinesia for patients suffering from Parkinson's Disease

Tom Berfelo, Feline Spijkerboer, Bernice Wulterkens, Marjolein Haveman

Abstract

The goal of our project is to design a device for quantification of bradykinesia in Parkinson's patients. This way, the determination of bradykinesia becomes objective. The developed device is able to measure the movement of the wrist. It contains a gyroscope to measure the angular velocity. Several subjects performed the experiment according to the composed protocol which stated to execute a pro-/supination movement of the lower arm. Various parameters, e.g. frequency and smoothness, are calculated from the gyroscope data and result in a UPDRS score to show the level of bradykinesia. Although there are some important discussion points, a set-up method for quantification of bradykinesia with high potential in the future is described in this article.

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Quantification of Parkinson’s Disease by the use of a smartphone

Mathijs van Schie, Wouter van 't Klooster, Marinka Oudkerk Pool, Emilie Klaver

This research uses an iPhone 4S to detect a decreasing speed of the pronation-supination movement. The pronation-supination movement of a patient with Parkinson's disease was measured for at least 20 seconds. The results indicate symptoms in the right hand, which diminishes at the next measurement. Therefore this method of measurement could be a valuable way to quantify Parkinson's disease. However, further research is needed to quantify this method.

Objective Analysis of Rigidity in Patients with Parkinson's Disease

Mark Scheeren, Esmée de Boer, Frank van der Velden, Wenche Kwinten

Parkinson’s disease (PD) is the second, most prevalent neurodegenerative disorder in the world. Typical PD symptoms like tremor, bradykinesia, postural instability and rigidity are at this moment evaluated by means of the Unified Parkinson’s Disease Rating System (UPDRS). In this study, a technique is developed to objectify the classification of rigidity in PD. Therefore, the Rigidity Tracker, existing of two gyroscopes and a force sensor is designed. The combination of those devices are attached on the upper and lower arm to measure the angle and torque of the elbow. From these measurements, the joint stiffness is determined. Joint stiffness is a representation of the degree of rigidity. The results showed a larger difference between the left and right arm in PD patients when compared to healthy subjects. The amount of force differs for all subjects and no obvious difference is seen between healthy subjects and PD patients. However, the results showed a difference in joint stiffness between subjects. The cause of this is unknown. Increased rigidity could be an explanation, however changes in input forces are another possibility. A difference is seen in average joint stiffness between patients and healthy subjects, which unfortunately could not be explained with this paper's set-up.

Quantification of bradykinesia during the pronation-supination test in patients suffering from Parkinson's Disease.

Judith Elshof, Majorie van Helvert, Michelle van der Stoel and Sophie Ligtenstein

Parkinson's Disease (PD) is a neurodegenerative disorder that can cause symptoms like tremor, rigidity, bradykinesia and postural disorders. Physicians rate the severity of this disease using the MDS-UPDRS scale, which leads to discrepancies between physicians. Therefore, methods are needed to quantify the symptoms of PD. In this study, a measurement device for quantifying bradykinesia during the pronation-supination test was designed. Results from one PD patient and ten healthy subjects were obtained. Various parameters were analysed, namely frequency, amplitude, amplitude times frequency, the courses of the previous mentioned factors and the amount of hesitations during the movement. Differences between healthy subjects and the patient were mostly present in the absolute values of the amplitude and frequency, but not in the courses. The measurement device has multiple advantages, but still some drawbacks as well. Recommendations include making a database with more results of patients and healthy subjects to be able to make a quantified rating scale for PD for application in clinic.

An objective method to quantify Parkinson's Disease using an accelerometer

Machteld Boonstra, Eline Schaft, Babette van de Werff, Sarah Verboom

Diagnosing a patient with Parkinson's Disease, bradykinesia and one other clinical sign have to be present. This physical examination is not quantitative. This paper focuses on an objective method to score the presence and the level of bradykinesia. A 3-axis accelerometer was used to assess the acceleration during four hand movements (finger-tapping, diadochokinesis, opening/closing of the hand and turning over the hand). The accelerometer was fixed on the tip of the forefinger. From these measurements the mean frequency and amplitude, changes in frequency and amplitude, percentage of movement and mobility were derived. An objective quantification may be derived from absolute values from the frequency and mobility of movements. Those factors seem to decrease significantly while the UPDRS increases.

Foot Surface Ratio During the Retropulsion Test of Patients with Parkinson's Disease

Stan Brinkman, Eline Boksem, Lisette Raasing, Nienke Idsardi

Abstract
The golden standard used to examine postural instability in Patients with Parkinson's disease is the retropulsion test, this test is graded subjectively. This study attemps to develop a more objective method to quantify postural instability, by developing a ratio related with instability grade. The ratio is described by dividing the minimal and maximal contact surface of a foot during the test. Therefore the feet are recorded during the test. A smaller surface ratio is expected in patients with instability problems. The developed method is cost effective, safe and easy to use. Unfortunately, the validity has not been established and therefore no relation can be established between the surface ratio and instability.

Optimization of the medication of a Parkinson patient using long-term assessment of the tremor with a Pebble smartwatch

Michelle van Mierlo, Huub Lievestro, Naric Durmus, Bart Witjes

Parkinson's Disease (PD) results in symptoms like akinesia, rigidity and tremor. This study explores long-term quantification of tremor to optimize medication using a smartwatch. The accelerometer of the smartwatch is used to measure acceleration. To analyse the data, the ratio between power in the tremor band (4-6 Hz) and total power was calculated. Long-term measurements of a PD patient with hardly visible tremor showed no difference compared to a healthy subject. Therefore, a short-term trial was performed with a PD patient with visible tremor. This data did show a clear increase of the power ratio. Long-term measurements of resting tremor proved possible in this study, but further research will have to optimize the tremor detection algorithm for long-term tremor monitoring.