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Application of nonlinear analysis for the assessment of gait in patients with Parkinson's disease

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ABSTRACT

BACKGROUND: Gait can be affected by diseases such as Parkinson's disease (PD), which lead to alterations like shuffle gait or loss of balance. PD diagnosis is based on subjective measures to generate a score using the Unified Parkinson's Disease Rating Scale (UPDRS). To improve clinical assessment accuracy, gait analysis can utilise linear and nonlinear methods. A nonlinear method called the Lyapunov exponent (LE) is being used to identify chaos in dynamic systems. This article presents an application of LE for diagnosing PD.

OBJECTIVE: The objectives were to use the largest Lyapunov exponents (LaLyEx), sample entropy (SampEn) and root mean square (RMS) to assess the gait of subjects diagnosed with PD; to verify the applicability of these parameters to distinguish between people with PD and healthy controls (CO); and to differentiate subjects within the PD group according to the UPDRS assessment.

METHODS: The subjects were divided into the CO group (n = 12) and the PD group (n = 14). The PD group was also divided according to the UPDRS score: UPDRS 0 (n = 7) and UPDRS 1 (n = 7). Kinematic data of lower limbs were measured using inertial measurement units (IMU) and nonlinear parameters (LaLyEx, SampEn and RMS) were calculated.

RESULTS: There were significant differences between the CO and PD groups for RMS, SampEn and the LaLyEx. After dividing the PD group according to the UPDRS score, there were significant differences in LaLyEx and RMS.

CONCLUSIONS: The selected parameters can be used to distinguish people with PD from CO subjects, and separate people with PD according to the UPDRS score.

KEYWORDS: gait, IMU, Parkinson disease, nonlinear analysis.