

## An association between gait cycle variation index and disease severity in Parkinson's disease

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### Abstract

We conducted an investigation into the association between the variation index of the gait cycle and disease severity in PD patients, using "an acceleration sensor". The subjects included 27 patients with PD. A variation index of the time was calculated for five gait cycles in the direct course using three axis acceleration sensors. The variation index of the gait cycle showed an equilateral association with UPDRS Part 1 and Part 2. A negative correlation was shown between walking speed and UPDRS Part 3. No correlation was found between disease severity and other indexes related to walking function. It was suggested that the patients with a high variation index of the gait cycle had high disease severity. Furthermore, the variation index of the gait cycle correlated with UPDRS Part 1. This suggests that the walk rhythm in PD is affected by mentation and feeling.

**Keywords:** Parkinson's disease, PD, gait cycle variation index, UPDRS, acceleration sensor

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### Introduction

The walking of patients with Parkinson's disease (PD) features walk dysrhythmia such as freezing of gait or gait festinating. Evaluation of the walk rhythm was performed visually and subjectively. In late years, walk analysis using "an acceleration sensor" was carried out. This enabled quantification of the walking ability. In this study, we conducted an investigation into the association between the variation index of the gait cycle and disease severity using "an acceleration sensor" in PD patients.

### Subjects and methods

The subject included 27 patients with PD. The age was  $65.6 \pm 6.5$  years old (mean  $\pm$  SD). The UPDRS was  $73.9 \pm 22.1$ . For an index regarding their walking, a variation index of gait cycle, 10m walking speed, step distance, and step number were used. UPDRS Part 1-4 was used as an index of disease severity. A variation index of the time was calculated for five gait cycles in the direct course using three axis acceleration sensors (Micro Stone company).

### Results

The variation index of the gait cycle showed equilateral association with UPDRS Part 1

(the items about mentation / feeling), Part 2 (an item about everyday life) and Part 3 (the item about the motor function) (Table). A negative correlation was shown with walking speed and UPDRS Part 3. No correlation was shown between disease severity and other indexes of walking function.

## Discussion

The presence of rigidity and/or tremor defines distinct clinical phenotypes of PD [2]. Motor impairment leads to specific gait characteristic in PD, such as shuffling gait, reduced step length, impaired gait initiation, and reduced gait speed. Gait impairment and consecutively reduced mobility with loss of independency lead to a severe reduction of quality of life in PD patients [3]. The MDS Unified Parkinson Disease Rating Scale (UPDRS) - Part III is the most commonly used scale to rate motor symptoms in PD [4], and is a widely accepted test to determine the efficacy of intervention in clinical studies. Our results showed that the variation index of the gait cycle correlated with disease severity of PD. In other words, it was

suggested that the patients with a high variation index of the gait cycle had high disease severity. Furthermore, the variation index of the gait cycle correlated with UPDRS Part 1. This suggests that the walk rhythm in PD is affected by mentation and feeling.

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Table 1. Association between gait function and disability scale of Parkinson's disease

UPDRS <sup>1)</sup>	Part 1	Part 2	Part 3	Part 4	Total
Gait cycle variation index	*2) <i>R</i> = 0.416 <i>P</i> = 0.035	**3) <i>R</i> = 0.555 <i>P</i> = 0.003	** <i>R</i> = 0.576 <i>P</i> = 0.002	<i>n.s.</i> <i>R</i> = 0.114 <i>P</i> = 0.578	** <i>R</i> = 0.574 <i>P</i> = 0.002
Gait speed	<i>n.s.</i> <i>R</i> = -0.320 <i>P</i> = 0.265	<i>n.s.</i> <i>R</i> = -0.397 <i>P</i> = 0.160	* <i>R</i> = -0.582 <i>P</i> = 0.029	<i>n.s.</i> <i>R</i> = 0.338 <i>P</i> = 0.237	<i>n.s.</i> <i>R</i> = -0.463 <i>P</i> = 0.096
Step width	<i>n.s.</i> <i>R</i> = -0.472 <i>P</i> = 0.088	<i>n.s.</i> <i>R</i> = -0.324 <i>P</i> = 0.258	<i>n.s.</i> <i>R</i> = -0.485 <i>P</i> = 0.079	<i>n.s.</i> <i>R</i> = 0.271 <i>P</i> = 0.349	<i>n.s.</i> <i>R</i> = -0.409 <i>P</i> = 0.146
Step number	<i>n.s.</i> <i>R</i> = 0.204 <i>P</i> = 0.484	<i>n.s.</i> <i>R</i> = -0.216 <i>P</i> = 0.458	<i>n.s.</i> <i>R</i> = -0.359 <i>P</i> = 0.208	<i>n.s.</i> <i>R</i> = 0.142 <i>P</i> = 0.628	<i>n.s.</i> <i>R</i> = -0.237 <i>P</i> = 0.415

1) UPDRS, Unified Parkinson's Disease Rating Scale; 2)  $P < 0.05$ ; 3)  $P < 0.01$