IS GAIT VARIABILITY RELIABLE?

Navrag Singh[1], Niklas König[1,2], Jonas von Beckerath[1], Linda Janke[1], William R. Taylor[1,2]
[1] *Julius Wolff Institute, Charité – Universitätsmedizin Berlin, Germany;*
[2] *Institute for Biomechanics, ETH Zürich, Switzerland*

Introduction

Gait variability is a commonly assessed marker for the evaluation of human mobility performance [Lord, 2011] and allows assessment of the neuromuscular system [Singh, 2012]. While its use in clinical settings towards identifying motor related pathologies such as e.g. future fallers [Hamacher, 2010] is increasing, it remains unknown under which conditions the assessment of variability is reliable. Common measures of variability are derived from the standard deviation (SD) of mean parameters. As estimations of mean and SD improve with increasing sample size, it is critical to understand how many gait cycles are required before variability of the underlying gait patterns can be reliably assessed. An additional hindrance is that most studies utilise non-continuous walking protocols that have been shown to artificially modify the variability of gait patterns [Paterson, 2009]. Therefore, through establishing a walking protocol that allows kinematic assessment of gait variability in a continuous manner, the aim of this study was to understand the conditions under which the parameters of gait variability can be reliably assessed.

Methods

Twelve healthy subjects (5 females; aged 28±3; height 175±11cm; weight 71±9kg) walked continuously for at least 10 minutes at preferred walking speed in a path that described an "8" on the floor. The two straight sections of the so-called "8walk" were each 10m in length and 0.5m wide. Kinematic data was collected from 6 markers attached to the dominant foot at 120Hz (Vicon, OMG). Parameters of spatial and temporal gait variability were computed for 10, 20, 30, 40, 50 and 60 consecutive gait cycles. Subjects completed the protocol twice, separated by an average of 3 days, and intersession reliability was evaluated by means of intra-class correlation coefficient (ICC2,1), test-retest variability (TRV in %) and Bland and Altman analysis (Bias and Limits of agreement [LoA]) [Bland, 1999]. Reliability of spatial and temporal variability was compared using coefficient of variation (CV).

Results

Mean gait parameters show excellent ICC values ranging from 0.88-0.98 with only 10 cycles. Gait variability revealed TRV ranging from 12-40% with less than 40 cycles. However, the random error levelled off beyond 40 cycles (Figure 1), and reached moderate to excellent reliability with ICCs of 0.54-0.92. The CV of spatial and temporal parameters averaged 0.16 and 0.04 respectively.

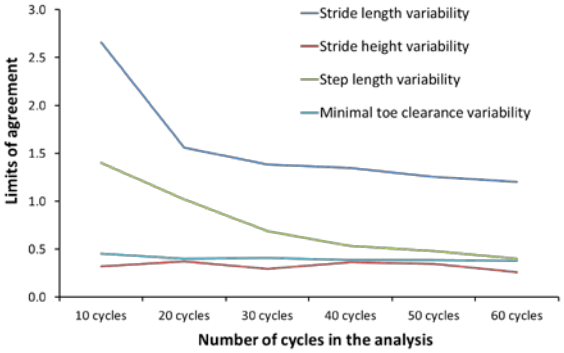

Figure 1: Limits of agreement for spatial gait variability

Discussion

While mean gait parameters can be assessed reliably within only 10 cycles, gait variability requires the assessment of substantially more cycles before it can be considered reliable. Further changes in LoA beyond 40 cycles were small, indicating this as a minimum target for evaluation. However, as spatial variability reached only moderate levels of reliability, the collection of at least 50-60 gait cycles should be recommended for the reliable assessment of gait variability. Although the assessment of 50-60 continuous cycles is currently difficult, new technologies such as accelerometers could offer promise for rapid and practical measurement of these key metrics of functional performance towards evaluation of neuromotor control in clinical settings.

References

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