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The gait deviation index: A new comprehensive index of gait pathology

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Abstract

This article describes a new multivariate measure of overall gait pathology called the Gait Deviation Index (GDI). The first step in developing the GDI was to use kinematic data from a large number of walking strides to derive a set of mutually independent joint rotation patterns that efficiently describe gait. These patterns are called *gait features*. Linear combinations of the first 15 gait features produced a 98% faithful reconstruction of both the data from which they were derived and 1000 validation strides not used in the derivation. The GDI was then defined as a scaled distance between the 15 gait feature scores for a subject and the average of the same 15 gait feature scores for a control group of typically developing (TD) children. Concurrent and face validity data for the GDI are presented through comparisons with the Gillette Gait Index (GGI), Gillette Functional Assessment Questionnaire Walking Scale (FAQ), and topographic classifications within the diagnosis of Cerebral Palsy (CP). The GDI and GGI are strongly correlated ($r^2 = 0.56$). The GDI scales with FAQ level, distinguishes levels from one another, and is normally distributed across FAQ levels six to ten and among TD children. The GDI also scales with respect to clinical involvement based on topographic CP classification in Hemiplegia Types I–IV, Diplegia, Triplegia and Quadriplegia. The GDI offers an alternative to the GGI as a comprehensive quantitative gait pathology index, and can be readily computed using the electronic addendum provided with this article.

Keywords: Gait pathology; Gillette gait index; Normalcy index; Outcome; Singular value decomposition

1. Introduction

Comprehensive measures of gait pathology are useful in clinical practice. They allow stratification of severity, give an overall impression of gait quality, and aid in objective evaluation of treatment outcome. There are many ways to gauge overall gait pathology. Parent report questionnaires such as the Gillette Functional Assessment Walking Scale (FAQ), observational video analysis schemes like the Edinburgh Gait Score, or rating systems such as the Functional Mobility Scale (FMS), can provide a general picture of gait impairment [1–3]. While parent and caregiver assessments are useful and practical, they lack the precision and objectivity provided by three-dimensional quantitative gait data.

Gait data can be used to assess pathology in a variety of ways. For example, stride parameters such as walking speed, step length, and cadence provide an overall picture of gait quality. These parameters are especially useful when non-dimensionalized to account for differences in stature [4]. It is possible, however, to walk with adequate stride parameters and still have significantly atypical joint motions and orientations. This suggests a need for three-dimensional gait data in assessing overall gait pathology. Interpreting three-dimensional gait data in a global sense is not a simple task.

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