



Further evidence of validity of the Gait Deviation Index

M. Molloy^a, B.C. McDowell^{a,*}, C. Kerr^{a,b}, A.P. Cosgrove^a

^a Gait Analysis Laboratory, Musgrave Park Hospital (Belfast HSC Trust), Northern Ireland, United Kingdom

^b School of Nursing and Midwifery, Queen's University Belfast, Northern Ireland, United Kingdom

ARTICLE INFO

Article history:

Received 18 November 2009

Received in revised form 28 January 2010

Accepted 29 January 2010

Keywords:

Gait

Cerebral palsy

Gait Deviation Index (GDI)

Validity

ABSTRACT

In this paper, the relationship of the Gait Deviation Index (GDI) to gross motor function and its ability to distinguish between different Gross Motor Function Classification System (GMFCS) levels was determined. A representative sample of 184 ambulant children with CP in GMFCS levels I ($n = 57$), II ($n = 91$), III ($n = 22$) and IV ($n = 14$) were recruited as part of a population-based study. Representative gait cycles were selected following a 3D gait analysis and gross motor function was assessed using the Gross Motor Function Measure (GMFM). GDI scores were calculated in Matlab. Valid 3D kinematic data were obtained for 173 participants and both kinematic and GMFM data were obtained for 150 participants. A substantial relationship between mean GDI and GMFM-66 scores was demonstrated ($r = 0.70$; $p < 0.001$) with significant differences in mean GDI scores between GMFCS levels ($p < 0.001$) indicating increasing levels of gait deviation in subjects less functionally able. The relationship between the GDI, GMFM and GMFCS in a representative sample of ambulators, lends further weight to the validity of the GDI scoring system. Furthermore it suggests that the subtleties of gait may not be wholly accounted for by gross motor function evaluation alone. Gait specific tools such as the GDI more likely capture both the functional and aesthetic components of walking.

© 2010 Elsevier B.V. All rights reserved.

1. Introduction

Due to the complexity and volume of data generated by three-dimensional gait analysis, categorisation of gait patterns in individuals with cerebral palsy (CP) has been the focus of numerous investigations. Such techniques seek to determine the extent of pathology and in many instances, assess the effectiveness of a given intervention. Primarily, classification techniques can be divided into two groups: qualitative and quantitative. The qualitative approach depends on the expertise of the clinician who attempts to categorise patients into pre-defined, distinguishable patterns. Examples of this type of approach have been documented in children with hemiplegia [1,2] and diplegia [3]. This type of approach is often useful in determining etiology and in some instances, can assist with formulating treatment plans [3]. Alternatively, quantitative methods mathematically analyse gait pattern deviation from a non-impaired sample and, though more objective, may be less user friendly in the clinical environment. This latter approach may be more useful in determining overall change in gait pattern and therefore be more useful as an

evaluative tool in intervention studies with large cohorts of subjects.

The quantitative approach has employed various techniques such as cluster analysis [4], neural networks [5] and fuzzy logic [6]. However it was the development of the Gillette Gait Index (GGI), often referred to as the normalcy index [7], that was most embraced in the clinical literature. This latter tool uses principal component analysis to identify how 16 selected gait variables in a person with pathological gait vary from those of a typically developed (TD) control group; differences are presented as a single value. The authors suggest that pre- and post-intervention GGI values could be used to determine any change in gait as a result of an intervention. More recently the original authors of the GGI have highlighted a number of its limitations [8]; these include the choice of the component parameters and the interdependence between the GGI and control data used. As a result of these limitations, a new quantitative measure – the Gait Deviation Index (GDI) – has recently been proposed [8]. Utilising pattern recognition, the GDI compares nine kinematic variables of a subject's gait against those of a control group; this requires kinematics from the pelvis and hip in all three planes, the knee and ankle in the sagittal plane and foot progression. Each lower limb is considered independently. This method of comparison involves compiling a large dataset composed of control and clinically impaired kinematic data, the aim being to reflect the extent of gait variation possible. Singular value decomposition is then employed to decompose the dataset whereby the range of

* Corresponding author at: Gait Analysis Laboratory, Musgrave Park Hospital, Stockman's Lane, Belfast BT9 7JB, Northern Ireland, United Kingdom.
Tel.: +44 28 9090 2849; fax: +44 28 9066 1112.

E-mail address: brona.mcdowell@belfasttrust.hscni.net (B.C. McDowell).