Gait & Posture 62 (2018) 75–79

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

An assessment of the relationship between the items of the observational Wisconsin Gait Scale and the 3-dimensional spatiotemporal and kinematic parameters in post-stroke gait

Agnieszka Guzik*, Mariusz Drużbicki, Grzegorz Przysada, Agnieszka Brzozowska-Magoń, Andżelina Wolan-Nieroda, Andrzej Kwolek

Institute of Physiotherapy of University of Rzeszów, Warszawska 26 a, 35-205 Rzeszów, Poland

ARTICLE INFO

Keywords:
Gait
Stroke
Wisconsin Gait Scale
3-dimensional gait analysis
Relationship

ABSTRACT

Background: There are few reports in the literature investigating the relationship between observational gait scales used to assess individuals after a stroke and objective data acquired from 3-dimensional gait analysis (3DGA).

Research question: The objective of this study was to compare the relationship between the specific items of the Wisconsin Gait Scale (WGS) and the matching 3-dimensional (3D) spatiotemporal and kinematic gait parameters in individuals after a stroke. In this way we evaluated whether using the simple, inexpensive, easy-to-use, observational WGS can fully substitute for the very costly and time-consuming 3DGA.

Methods: The study group comprised 50 participants who had experienced a stroke and were in the chronic stage of recovery. The study participants' gait was evaluated by means of the WGS; spatiotemporal and kinematic gait parameters were examined in the Gait Laboratory with the use of the BTS Smart system. The 3D recording of gait was performed using 2 video cameras positioned in such a way that it was possible to obtain images in the frontal and the sagittal plane.

Results: The findings show strong ($0.7 \le |R| < 0.9$; $p < 0.001$) or very strong ($0.9 \le |R| < 1$; $p < 0.001$) correlation between the specific items of the WGS and the matching 3D gait parameters. Significance: The WGS is a diagnostic tool useful for conducting observational gait analysis in people with post-stroke hemiparesis and in situations when the costly objective methods of gait assessment cannot be applied for various reasons, the scale may be an effective tool enabling the assessment of gait. The WGS may be particularly useful in the subacute period of stroke as video recording of walking takes considerably less time than 3DGA.

The study has been registered at the ClinicalTrials.gov, ID: ACTRN12617000436370.

1. Introduction

Gait analysis is commonly used in clinical practice to diagnose gait disorders and to define suitable, adequately targeted and effective treatment programs [1–3]. Gait analysis is the primary objective in the treatment approach to hemiparetic individuals after a stroke, both in terms of kinematics and spatiotemporal gait parameters, because hemiparetic individuals after a stroke experience numerous impairments in their walking skills which are reflected in spatiotemporal and kinematic gait parameters [4–7].

The highly accurate, objective assessment of these parameters is possible because of advanced instrumented 3-dimensional gait analysis (3DGA). Yet, the assessment of walking skills based on 3DGA generates a large amount of complex data, and despite its objectivity, the application of this method is rather complicated. Therefore, the interpretation of results acquired through 3DGA, and then linking them with neurological deficits in individuals after a stroke is a very difficult task [8–10].

Due to the above drawbacks of 3DGA, healthcare professionals commonly choose quick, simple, and inexpensive scales and tests. However, despite the numerous advantages, observational gait analysis also presents with certain limitations. Toro et al. [11] in a review focusing on observational gait assessment in clinical practice argued that since it is a subjective method it may lack validity and reliability. Muro-de-la-Herran et al. [12] in a review of gait analysis methods, suggested that observational gait assessment produces subjective measurements,

* Corresponding author.
E-mail addresses: agnieszkadepa2@wp.pl (A. Guzik), mdruzb@ur.edu.pl (M. Drużbicki), g.przysada@interia.pl (G. Przysada), brzoza_a@poczta.onet.pl (A. Brzozowska-Magoń), wolan.a@gmail.com (A. Wolan-Nieroda), kwoleka@o2.pl (A. Kwolek).

https://doi.org/10.1016/j.gaitpost.2018.03.009
Received 16 August 2017; Received in revised form 1 March 2018; Accepted 4 March 2018
0966-6362/

which particularly affect accuracy and precision, which negatively impacts the diagnosis, follow-up and treatment. Furthermore, the number of studies assessing the reliability and validity of observational gait analysis is limited [2,13–16].

Most observational scales used for the evaluation of gait in individuals after a stroke are functional scales. The Wisconsin Gait Scale (WGS) developed by Rodriguez et al. is a scale for the evaluation of gait quality [17] and the evaluation of inter-rater and intra-rater reliability of the WGS has been performed by Yaliman et al. [14] and Wellmon et al. [16]. The WGS was shown to be reliable, demonstrating good inter-rater and intra-rater reliability and may provide an objective means to record findings from observational gait analysis [14,16].

The WGS takes into account 14 observable gait parameters, grouped into 4 subscales focusing on the specific gait phases: stance phase, toe off, swing phase and heel strike of the affected leg. The items of the scale are designed to assess spatiotemporal (subscale 1) and kinematic parameters of gait (subscale 1, 2, 3 and 4). Based on the video recordings, the evaluator scores the participant's performance for the items of the WGS [17,18].

Motivation for the study came from our previous findings which showed a relationship between 3D spatiotemporal gait parameters and the global score obtained based on the observational WGS in individuals after a stroke [19]. These results encouraged us to carry out further analysis, in order to examine the specific items of the WGS and compare them separately with the selected parameters identified using 3DGA. The study was also inspired by the fact that there is only limited literature investigating the relationship between observational gait scales used for the assessment of individuals after a stroke and objective data acquired in 3DGA. Other researchers have emphasized the need for such comparisons [13,20].

The purpose of the study was to investigate the correlations between spatiotemporal parameters acquired in 3DGA and spatiotemporal traits assessed as subscale 1 of the WGS. We also aimed to compare the 3D kinematic parameters and the kinematic parameters evaluated by subscales 1, 2, 3 and 4 of the WGS, and we intended to find out whether the simple, inexpensive, easy-to-use, observational Wisconsin Gait Scale could fully substitute for the very costly and time-consuming 3DGA.

2. Methods

2.1. Study participants

The study group comprised 50 participants who had experienced a stroke and were in the chronic phase of recovery. The study included patients treated at the Rehabilitation Clinic in the Provincial Hospital No. 2 in Rzeszow, Poland. The following patient inclusion criteria were defined: a single ischaemic stroke incident confirmed by computed tomography (CT) or magnetic resonance imaging, aged 30–75 years, at least 6 months since the occurrence of stroke, unilateral paresis, ability to walk without the assistance of another person (the use of a cane, crutches or AFO orthosis was permitted), the ability to walk independently for a minimum of 10 m and to leave home independently or with the help of another person. Exclusion criteria included a second or another stroke incident, cognitive function deficits impairing the ability to understand and follow instructions, unstable medical conditions, lower limb contractures, and orthopaedic, rheumatic and neurological co-morbidities impairing ambulation. Study participants lived in their own homes and were brought to the centre by their caretakers. The research protocol was approved by the local Bioethics Commission of the Medical Faculty (5/2/2017); the study was registered at the Australian New Zealand Clinical Trials Registry (ACTRN12617000436370). Experimental procedures met the requirements of the Declaration of Helsinki and all subjects gave their informed written consent to participate in the study. The group characteristics are shown in Table 1.

Table 1
Baseline characteristics of individuals after a stroke.

	Group (n = 50)
Age [years], mean (SD)	60.9 (11.2)
Sex [women/men]	18/32
Paretic limb [right/left]	35/15
Time from stroke month, mean [range]	42.0 [8–120]
Brunnström recovery stage	3–4
Gait speed (m/s), mean (SD)	0.65 (0.20)

SD – standard deviation.

2.2. Data collection

The study participants' gait was evaluated using the WGS and spatiotemporal and kinematic gait parameters were examined in the Biomechanics Laboratory of the Physiotherapy Institute of the University of Rzeszow. Three dimensional walk tests were performed by a staff member with more than 10 years of experience in the use of the BTS Smart system (DX700, 6 cameras, maximum acquisition frequency 1000fps, Sensor Resolution 1,5Mpixel) from BTS Bioengineering (BTS Bioengineering, Milan, Italy). Passive reference markers were positioned in compliance with the internal protocol of the system (Helen Hayes (Davis) Marker Placement) on the sacrum, pelvis (the anterior and posterior iliac spine), femur (lateral epicondyle, great trochanter and in the lower one-third of the shank), fibula (lateral malleolus, lateral end of the condyle in the lower one-third of the shank) and foot (metatarsal head and heel) [21]. The participants were asked to walk at a comfortable speed and during the test were allowed to use auxiliary devices such as canes, tripods and elbow crutches. During the test, a minimum of 6 passages were recorded at a distance of 10 m for each participant. Tracker and Analyzer programs (BTS Bioengineering) were used to calculate mean values of spatiotemporal and kinematic parameters based on complete records. Further analyses took into account the following parameters: 1) spatiotemporal parameters including stance time, the difference in duration of the stance phase between the unaffected and affected side, stride time, stride length, step length and step width, 2) kinematic parameters of the hip, knee, ankle joints and pelvis.

The video recording was done concurrently with the 3D recording. Two video cameras (BTS Vixta, BTS Bioengineering Corp) were positioned so that it was possible to obtain images in both the frontal and the sagittal plane and they were synchronised with one another. The walking path was 10 m long. One camera was aligned in the direction of the gait in the frontal plane, the second camera recorded the image in the sagittal plane which was halfway along the walking path at a distance of 2 m from the path. The cameras were set to allow visualization of 3 walking trials examining the unaffected and the affected sides for a total of 6 ambulation trials. The subjects were instructed to walk the defined distance at a self-selected (comfortable) speed, with the support of orthopaedic aids if used on a regular basis. The video recording was performed by a staff member which documented a 3D walk. Video recordings were prepared on separate CDs.

The interpretation of the recordings and WGS-based gait assessment were performed by a physiotherapist with more than 10 years of experience in working with patients who had experienced a stroke (trained in the Bobath concept for hemiplegia). The physiotherapist was trained in the use and interpretation of the WGS and had participated in a previously published study [19]. The physiotherapist who evaluated the walk using WGS did not participate in the study and analysis of the 3D gait.

The WGS takes into account 14 observable gait parameters (the scale is described in the Introduction section). A total sum score, which can range from 13.35 to 42 points, was calculated for the items. Items 2–10 and 12–14 are summed. Items 1 and 11 both contribute to the summary score but each is weighted by 3/5 and 3/4, respectively,