Multiple Sclerosis and Related Disorders 17 (2017) 202–206

Contents lists available at ScienceDirect

Multiple Sclerosis and Related Disorders

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

The walking speed reserve in low disabled people with multiple sclerosis: Does it provide greater insight in detecting mobility deficits and risk of falling than preferred and fast walking speeds?

Alon Kalron[a,b,*], Shay Menascu[b,c], Mark Dolev[c], Uri Givon[b,c]

[a] Department of Physical Therapy, School of Health Professions, Israel
[b] Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel
[c] Multiple Sclerosis Center, Sheba Medical Center, Tel-Hashomer, Israel

ARTICLE INFO

Keywords:
Walking speed reserve
Gait
Multiple sclerosis
Neurological
Velocity

ABSTRACT

The extent of an increase from a preferred walking speed (PWS) to a fast walking speed (FWS) is defined as the walking speed reserve (WSR). The WSR is unique as it reflects an individual's ability to increase their walking speed on demand. The primary objective of this study was to examine whether the WSR was more advantageous than the PWS and FWS in terms of reflecting mobility deficits and risk of falling associated with multiple sclerosis (MS). The patient group included 235 people with MS (PwMS) (139 women) with a mean age of 43.6 (SD = 13.6) years. The WSR, PWS and FWS (m/s) were: 0.47 (SD = 0.29), 0.98 (SD = 0.28) and 1.45 (SD = 0.47), respectively. Significant correlation scores were found between the WSR and all clinical walking and balance outcome measures; Pearson's rho ranged from 0.240 to 0.517. However, stronger correlation scores were found between the PWS, FWS and all clinical walking and balance outcome measures with the Pearson's rho ranging from 0.415 to 0.797. In terms of fall status, non-significant differences were observed between the fallers (n = 133) and non-fallers' (n = 102) groups with respect to the WSR scores. We found that the PWS and FWS were more instructive measures for assessing mobility deficits and fall status in PwMS than the WSR. Nevertheless, we do not rule out the possibility that the WSR score may be a preferred predictor of other adverse events related to MS, such as lower limb muscle weakness, spasticity and aerobic capacity.

1. Introduction

Walking difficulties in people with multiple sclerosis (PwMS) are one of the most disabling symptoms as it affects mobility and quality of life (Motl and Learmonth, 2014). Typical changes in walking include a slower speed, shorter strides and decreased cadence which significantly deteriorates over time (Comber et al., 2017). Furthermore, PwMS, who exhibit an asymmetric walking pattern and a wider width between strides, are at a greater risk of falling (Kalron and Givon, 2016), which is a cause of morbidity and in severe cases, mortality (Motl, 2013).

The extent of an increase from a preferred walking speed (PWS) to a fast walking speed (FWS) is defined as the walking speed reserve (WSR) (Middleton et al., 2016a, 2016b). The WSR is unique as it reflects an individual's ability to increase their walking speed on demand whilst associated with many daily living activities, such as when a person attempts to catch a bus/train or crossing the street when the traffic light suddenly begins to blink. People may also need to ambulate quickly indoors, such as running to answer a ringing phone and/or the doorbell, shutting off the stove when the timer buzzes, etc.

Low WSR values imply that the individual typically walks at, or close to, their maximal speed yet lacks the capacity to increase their walking speed in response to different environmental demands. Inability to increase walking speed on demand has been found amongst people affected by polio (Klein et al., 2008), chronic stroke survivors (Middleton et al., 2016a) and older adults (Middleton et al., 2016a). Recently, Middleton et al. (2017) found that 58.9% of individuals suffering from chronic stroke were unable to increase their walking speed on demand; balance impairments were noted as a significant contributor to this difficulty. Furthermore, Callisaya et al. established that low WSR scores were correlated with a cognitive decline in 681 older adults (Callisaya et al., 2017).

Comber et al. confirmed that PwMS walk slower at both preferred and accelerated speeds (Comber et al., 2017), however, at present, no studies (according to the PubMed database) have as yet published

* Correspondence to: Department of Physical Therapy, Sackler Faculty of Medicine, Tel-Aviv University, Israel.
E-mail addresses: alonkalr@post.tau.ac.il (A. Kalron), Shay.Menascu@sheba.health.gov.il (S. Menascu), Mark.Dolev@sheba.health.gov.il (M. Dolev), Uri.Givon@sheba.health.gov.il (U. Givon).

http://dx.doi.org/10.1016/j.msard.2017.08.010
Received 3 July 2017; Received in revised form 14 August 2017; Accepted 16 August 2017

outcomes relating to the WSR in the MS population. This information may have clinical implications when assessing and treating mobility deficits in PwMS, ie there is a chance that PwMS who are already walking "at capacity", namely a low WSR, are at the greatest risk of falling and suffering from mobility impairments. Thus, by evaluating their WSR, we may identify these PwMS and furnish specific training exercises aimed at increasing their walking speed on demand. Furthermore, there is a chance that the WSR may serve as a higher quality marker for general neurological disability and walking and balance impairments compared to the traditional outcome walking measures.

Therefore, the primary objective of the current study was to examine the WSR values in a large cohort of PwMS (n = 235). Specifically, we examined whether the WSR is more advantageous than the PWS and FWS in reflecting mobility deficits and risk of falling associated with MS. We verified the association between the WSR with validated gait and balance tests in PwMS and examined whether the WSR differed between MS fallers and non-fallers.

2. Methods

2.1. Study participants

Retrospective data was collected from the Multiple Sclerosis Center, Sheba Medical Center, Tel Hashomer, Israel's computerized database, a population-based registry documenting demographic and clinical data of all PwMS followed at the Center from January 2012 through March 2017.

Patients were selected according to the following inclusion criteria: (1) a neurologist-confirmed diagnosis of definite MS (Polman et al., 2011); (2) < 7.0 on the expanded disability status scale (EDSS) administered by a certified neurologist, corresponding to the ability to walk at least 20 m without resting (Kurtzke, 1983); (3) performed instrumented and clinical walking tests; (4) outcome measures assessed within a 3-month interval and no relapse; and (5) relapse-free for at least 60 days prior to testing.

Exclusion criteria included: (1) orthopedic disorders that could negatively affect mobility; (2) pregnancy; (3) cardiovascular or respiratory disorders; (4) or taking steroids or fampridine. The integrity of the data registry was evaluated by a computerized logic-algorithm-questioning process, identifying data entry errors. The study was approved by the Sheba Institutional Review Board. All participating subjects signed an informed consent form for use of their data in the research project.

2.2. Walking speed

PWS was assessed via the GAITRite™ system (CIR Systems, Inc. Haverton, PA, USA), which consists of a 4.6 m long electronic walkway containing 2304 compression-sensitive sensors arranged in a grid pattern. As the subject ambulates across the walkway, pressure is exerted by his feet, thus activating the sensors. Simultaneously, targeted software utilizes special algorithms to automatically group the activated sensors and form footprints. The system integrates all footprints and provides spatio-temporal parameters, including velocity. All participants were instructed to walk across the walkway at their "usual, comfortable speed", in one direction, with their preferred walking aids, without stopping. Participants walked 2 m before starting to walk on the mat and stopped 2 m after walking on the mat in order to eliminate data for gait initiation and termination. Each participant performed six consecutive walking trials. The values from all trials were subsequently averaged to produce the final PWS.

FWS was assessed by the Timed 25-Foot Walk Test (T25FW), a first component of the MS functional composite (Fischer et al., 1999). The participant was asked to stand just behind the 25 foot starting point and instructed as follows: "I'd like you to walk as fast as possible, but safely. Do not slow down until after you've passed the finish line". Timing begun when the lead foot crossed the starting position. The examiner walked alongside the patient as he/she completed the task. Timing was stopped once the lead foot crossed the finish line. Walking time was recorded within a 0.1 s, rounding off as needed. Each participant performed two consecutive walking trials. The values from both trials were then averaged to produce the final result. WSR was calculated as the difference between the individual's FWS and PWS (WSR = FWS – PWS). WSR was reported in meters per second.

2.3. Clinical gait and balance measures

Clinical gait and balance tests included the 2-min Walk Test (2MWT) (Gijbels et al., 2011), the Timed Up and Go (TUG) Test, the T25FW (Learmonth et al., 2012) and the Four Square Step Test (FSST) (Dite and Temple, 2002). The self-reported questionnaires included the Multiple Sclerosis Walking Scale (MSWS-12) (Hobart et al., 2003), the Modified Fatigue Impact Scale (MFIS) (Tellez et al., 2005) and the Falls Efficacy Scale International (FES-I) (Delbaere et al., 2010). These tests were selected because they provide clinically meaningful scores of gait and balance performance in PwMS (Baert et al., 2014). Participants were divided into groups based on their fall history (fallers and non-fallers); a fall was defined as an event where the participant unintentionally came to rest on the ground or a lower level (Finlayson et al., 2006). A faller was defined as a participant who had experienced at least two falls during the previous year. Two or more falls were selected since it is questionable whether a single fall clearly classifies an individual as a faller (Gunn et al., 2013).

2.4. Statistical analysis

Descriptive statistics were calculated for age, height, weight, gender, disease duration, EDSS, ambulatory and walking parameters. All data were normally distributed according to the Kolmogorov-Smirnov test. PwMS were divided into two levels of disability based on their EDSS score: mild (EDSS = 0–4.0) and moderate (EDSS = 4.5–6.5). An EDSS score ranging from 0 to 4.0 denotes patients who are fully ambulatory without aid; a score from 4.5 to 6.5 reveals moderate impairment in ambulation (Kurtzke, 1983). Pearson's r correlation coefficients examined the relationship between the three walking speed parameters (PWS, FWS, WSR) and the 2MWT, T25FW, TUG, FSST. Spearman's rank-order correlation coefficient tests examined the correlations between the MSWS-12, MFIS and FES-I. The ANOVA test assessed the differences in the walking speed parameters between fallers and non-fallers. All analyses were performed using the SPSS software (Version 23.0 for Windows, SPSS Inc. Chicago, IL, USA). P-values reported were two-tailed. The level of significance was set at $P \leq 0.05$.

3. Results

The patient group included 235 PwMS (139 women) with a mean age of 43.6 (SD = 13.6) years. The EDSS score was 3.5 (SD = 1.7) indicating minimal to moderate neurological disability. In terms of EDSS categories, the scores of the pyramidal, cerebellar and sensory divisions were 2.1 (SD = 1.1), 1.3 (SD = 1.1) and 1.0 (SD = 1.1), respectively. Other participants' related clinical scores are outlined in Table 1.

The WSR, PWS and FWS (m/s) of the total sample were 0.47 (SD = 0.29), 0.98 (SD = 0.28) and 1.45 (SD = 0.47), respectively. Mild MS individuals walked significantly faster than moderate MS patients in both PWS (1.08 (SD = 0.25) vs 0.79 (SD = 0.25), P-value < 0.001) and FWS (1.60 (SD = 0.42) vs. 1.17 (SD = 0.33); P-value < 0.001). Furthermore, the mild group demonstrated an elevated WSR compared to the moderate group, 0.52 (SD = 0.30), 0.38 (SD = 0.24); P-value < 0.001, respectively (Table 1).

Significant correlation scores were found between the WSR and all clinical walking and balance outcome measures in the total sample; the