Gait & Posture 57 (2017) 224–229

Contents lists available at ScienceDirect

Gait & Posture

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

Full length article

Somatosensory impairment and its association with balance limitation in people with multiple sclerosis

Akram Jamali[a,b], Ebrahim Sadeghi-Demneh[a,*], Niloufar Fereshtenajad[a,b], Susan Hillier[c]

[a] Musculoskeletal Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
[b] Research Committee of Rehabilitation Students (Treata), Isfahan University of Medical Sciences, Isfahan, Iran
[c] Sansom Institute of Health Research, Division of Health Sciences, University of South Australia, Australia

ARTICLE INFO

Keywords:
Multiple sclerosis
Somatosensory impairments
Balance

ABSTRACT

Background: Somatosensory impairments are common in multiple sclerosis. However, little data are available to characterize the nature and frequency of these problems in people with multiple sclerosis.
Objective: To investigate the frequency of somatosensory impairments and identify any association with balance limitations in people with multiple sclerosis.
Methods: The design was a prospective cross-sectional study, involving 82 people with multiple sclerosis and 30 healthy controls. Tactile and proprioceptive sensory acuity were measured using the Rivermead Assessment of Somatosensory Performance. Vibration duration was assessed using a tuning fork. Duration for the Timed Up and Go Test and reaching distance of the Functional Reach Test were measured to assess balance limitations. The normative range of sensory modalities was defined using cut-off points in the healthy participants. The multivariate linear regression was used to identify the significant predictors of balance in people with multiple sclerosis.
Results: Proprioceptive impairments (66.7%) were more common than tactile (60.8%) and vibration impairments (44.9%). Somatosensory impairments were more frequent in the lower limb (78.2%) than the upper limb (64.1%). All sensory modalities were significantly associated with the Timed Up and Go and Functional Reach tests ($p < 0.05$). The Timed Up and Go test was independently predicted by the severity of the neurological lesion, Body Mass Index, ataxia, and tactile sensation ($R2 = 0.58$), whereas the Functional Reach test was predicted by the severity of the neurological lesion, lower limb strength, and vibration sense ($R2 = 0.49$).
Conclusions: Somatosensory impairments are very common in people with multiple sclerosis. These impairments are independent predictors of balance limitation.

1. Introduction

Multiple sclerosis (MS) is a chronic demyelinating disease of the central nervous system (CNS) and known as the most common neurological condition in 20 to 50 year-old adults [1]. The impact of pathology on the CNS can result in significant restrictions of mobility due to impairments in the sensory, motor, and cognitive systems [2]. The World Health Organization (WHO) has identified sensory impairments as a prevalent symptom of MS [3]. Up to 80% of people with multiple sclerosis (PwMS) showed degrees of sensory impairment in previous investigations [4–6]. There is a considerable volume of evidence that the sensory system plays an important role in regulating postural control and human balance [7,8]. It has also been substantiated in previous studies that poor sensation can be associated with compromised motor control and limited balance in PwMS [9,10]. Postural control needs the sound functioning of multiple inter-related systems including sensory (vestibular, visual, and somatosensory), motor, and cognitive [11]. Intact somatosensory information is essential to provide feedback for motor activity, human mobility and motor learning [12]. Addressing somatosensory impairments can be an important aspect in the rehabilitation of PwMS [12]. Emerging findings indicate that sensory-based interventions may improve the motor activity of individuals with MS [13,14]. These studies have indicated that greater improvement in functioning is achieved when sensory strategies were included in the treatment [13]. It is therefore important to pay more attention to the sensory components while tailoring a rehabilitation plan for PwMS.

The assessment of somatosensory impairments is common in clinical practice [15], but there is relatively little research on rehabilitation programs which may positively influence somatosensory abilities in PwMS. One possible reason for this issue is the lack of a precise and

* Corresponding author at: No. 320, School of Rehabilitation Sciences, Isfahan University of Medical Sciences, Hezae Jerib St., Isfahan, Iran.
E-mail address: sadeghi@rehab.mui.ac.ir (E. Sadeghi-Demneh).

http://dx.doi.org/10.1016/j.gaitpost.2017.06.020
Received 24 August 2016; Received in revised form 4 June 2017; Accepted 22 June 2017
0966-6362/

clinically accessible method to measure sensory modalities affected in PwMS. Sensory assessment can be a good prognostic tool to either assess the underlying mechanisms of balance limitations [10] or to plan a comprehensive and effective treatment to retrain or compensate for mobility problems. There are many previous studies which have reported aspects of somatosensory impairments in PwMS [4–6,9,16–18]. However, most studies focused on the sensory measurement of only one body area [9,16–18] or only one somatosensory modality [16,17] in a relatively small group of subjects [5,9,16,18]. Quantitative measurement of somatosensory impairments was lacking in some reports [4,10]. Study heterogeneity in terms of type of sensory modality measured, body area assessed and study population is such that it is difficult to estimate the prevalence of somatosensory impairments or identify the nature of somatosensory loss in PwMS.

The current study addressed the missing components in these previous studies by assessing across a spectrum of sensory modalities and for multiple body parts in a larger sample group. A group of healthy people were also recruited to examine whether the quantitative somatosensory measures were sufficiently sensitive to detect differences between PwMS and matched controls without neurological impairment. The objective of this study was to undertake a comprehensive investigation to (a) clarify the frequency and type of somatosensory impairments across three modalities, (b) map these disorders in the body extremities and (c) explore any association between somatosensory impairments and limitation of balance outcomes in a larger-scaled sampling of PwMS.

2. Method

2.1. Participants

This cross-sectional study recruited a convenience sample of 89 PwMS and 30 healthy subjects. PwMS were recruited from the outpatients list of a local MS clinic (Neurology Unit, Alzahra Hospital, Isfahan, Iran) which was the main referral center within the province. Participants had relapsing-remitting MS diagnosed by a neurological specialist, according to Mc Donald's criteria [19]. PwMS were recruited if they had the ability to walk a 10 m distance without assistance of another person or any device. Participants were excluded if they had a relapse within the last three months, a history of fracture or surgical operation in their lower extremity, visual impairments (Ophthalmoplegia or optic neuritis) or other disorders of the central and peripheral nervous system affecting somatosensory or mobility function (i.e. epilepsy or diabetes). In this study, 7 potential participants were excluded, after initially expressing interest, due to recent history of hip fracture and surgery (2 volunteer), epilepsy (1 volunteer), recent relapse (2 volunteers) and the lack of ability to walk independently (2 volunteers). Therefore the study retained 82 people with relapsing-remitting MS (70 females and 12 males, age 36 ± 9 years, height 163 ± 7 cm, weight 62 ± 11 kg), an Expanded Disability Status Scale (EDSS) score of 3.5 ± 1.36 (EDSS range is 0–10; this score indicates mild disability) [20], and duration of illness of 7.5 ± 5 years. Thirty age, gender, and body-mass index matched healthy control individuals (26 females and 4 males, age 32 ± 10 years, height 165 ± 8 cm, weight 64 ± 14 kg) were recruited from University staff, students, and relatives of students or PwMS. Ethical approval was obtained from the Isfahan University of Medical Sciences Ethics Committee (Isfahan, Iran) prior to the study. A consent to participate in the study was signed by all study participants.

2.2. Procedure

Firstly, demographic and pathological information were recorded, and then standardized functional tests for balance, namely the Functional Reach Test (FRT) and Timed Up and Go (TUG), were performed. Pain was quantified using a 100 mm Wong-Baker FACES Pain Rating Scale [21]. Fatigue was measured using the Fatigue Severity Scale (FSS) [22]. Spasticity was measured using the Modified Ashworth Scale (MAS) in the upper limb (elbow, wrist, fingers) and lower limb (hamstrings, quadriceps, hip adductors and ankle plantar flexors) [23,24]. Ataxia was tested using the Brief Ataxia Rating Scale (BARS) [25]. Muscle strength in the hand and quadriceps, were measured using a hand grip dynamometer and digital muscle tester, respectively. All tests were run in a random order determined by drawing concealed envelopes from a hat. Data collection was completed in a single session at the University's research facility.

2.3. Somatosensory assessment

Somatosensory assessment included the testing of two common sensory modalities (proprioception and tactile) and two aspects of these modalities (detection and discrimination) according to the Rivermead Assessment of Somatosensory Performance (RASP) method [15]. This method was designed for the clinical assessment of people with neurological conditions; acceptable test-retest and intra-rater reliability and face, construct, concurrent, and predictive validiy are reported for the modalities used in this study [15]. According to the RASP protocol, we tested skin touch and localization at the 10 regions of the body using a 10–gr monofilament (Semmes-Weinstein Monofilament), while volunteers were in the supine position and their eyes were closed [15]. Regions on the body included two points on the face (right and left cheek), four points on both hands (palmar and dorsal) and four points on both feet (plantar and dorsal). Testing was done in two stages: detection and localization and each step were repeated 6 times for each point [15].

According to the RASP method, proprioceptive assessment included two stages: movement detection and then movement direction. The joints tested included the elbow, wrist, thumb, ankle and big toe [15]. The body joints were moved passively by an examiner while participant's eyes were kept closed. Participants were asked to indicate once they felt their body segment was moving, then they were asked to indicate the direction of movement. Each test was repeated six times for each joint [15,26].

Vibration testing was conducted using a 128 Hz tuning fork applied to the bony prominences of the first metatarsal head, medial malleolus at the foot and ulnar styloid at the wrist. The duration of vibration was recorded with a stopwatch, started once the fork's base touched the participants skin and stopped once the participant verbally indicated "the vibration is finished" [27]. The participants kept their eyes closed during the tests and the average of three trials was calculated as representative data to quantify the vibration sensation. To avoid intertester variability of the sensory tests using the tuning fork, all tests were carried out by the same examiner throughout the study. Good reliability and validity data have been reported for the measurement of vibration in PwMS [28].

2.4. Assessments of balance limitation

The standing Functional Reach Test evaluates balance limitation by measuring the distance which participants can reach beyond arm's length without taking a step [29,30]. This test was measured with a ruler set at the participant's shoulder height. The first measurement was collected as a 'practice' then the test was repeated three times and the mean values calculated. The FRT is reported as a valid and reliable test to measure motor ability [31]. The Timed Up and Go (TUG) test assesses balance by measuring the time taken for the participant to stand up from a chair, walk 3m, turn around, walk back, and sit down. Three trials were recorded for each participant and averaged. The TUG has good validity and reliability as a measure of physical mobility [32].

2.5. Data analysis

Descriptive statistics were used to present an overview of the