Editor’s note: This online-only document contains the full poster abstracts. The abstract titles, authors, and author affiliations were also published in the print edition of IJMSC’s Winter 2013 issue.

(1) COMPARISON OF AN INTERMITTENT VS. CONTINUOUS WALKING PROGRAM IN PERSONS WITH MULTIPLE SCLEROSIS USING THE 6-MINUTE WALK TEST: A RANDOMIZED CROSSOVER PILOT STUDY

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Introduction: Difficulty with gait is one of the most common complaints of persons with multiple sclerosis (PwMS) and can be due to many causes, including neurogenic fatigue. Neurogenic fatigue can prevent PwMS from walking longer distances and thus limit ability to improve gait endurance. Intermittent walking, a technique in which people take breaks during
walking rather than walking continuously, may allow for PwMS to walk longer distances with less accrual of fatigue. The purpose of this ongoing pilot study was to examine whether a program of intermittent walking will result in a greater improvement in gait endurance in PwMS than a continuous walking program. **Subjects and Methods:** A randomized crossover design was used. Subjects were randomized into intermittent (INT) and continuous (CONT) groups. All subjects performed a baseline 6-Minute Walk test (6MW) after which they performed a training regimen of eight 6-minute walks over a 4-week period, followed by a 6MW posttest. Subjects in the INT group trained with three 2-minute walks interspersed with 2-minute seated rests, while the CONT group trained for 6 minutes continuously. Subjects then underwent a 4-week detraining period, followed by another 4-week walking period in which they performed whatever type of training they did not perform originally, with 6MWs performed before and after the eight training bouts. **Results:** At the time of this poster, five subjects have completed both conditions. Intermittent training resulted in a significant ($F_{1,4} = 66.682, P < .001$) improvement in 6MW (75.8 feet) relative to continuous training, which resulted in a decrease of 42.6 feet. **Discussion:** Despite the small sample size, intermittent walking was superior to continuous walking in improving 6MW performance. This suggests that gait endurance in MS may be better improved with gait training that emphasizes intermittent rests as opposed to walking continuously.

(2) **CONSTRUCT VALIDITY OF THE FUNCTIONAL GAIT ASSESSMENT IN PERSONS WITH MULTIPLE SCLEROSIS**

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Background: The Functional Gait Assessment (FGA)\textsuperscript{1,2} is based on the Dynamic Gait Index,\textsuperscript{3} and evaluates dynamic balance and gait. However, validity of the FGA has not been investigated in multiple sclerosis (MS). Objective: To investigate construct validity of the FGA: convergent, discriminant, and known groups. Methods: Baseline data of the first 50 participants in a multicenter experimental study were used. Only persons able to maintain tandem position with arms close to the trunk for >30 seconds were included; the mean age was 54 (SD 10) years and the mean time since diagnosis was 14 years. Forty-one persons (82\%) were female, and 24 (48\%) reported ≥1 falls in the 8 weeks prior to assessment. The FGA consists of ten gait activities: walk at normal speed, with altering speed, with vertical and horizontal head turns, with eyes closed, over obstacles, in tandem, backward, and stair climbing. Items are scored from 0 to 3, with lower scores indicating greater impairment. Other measures completed were Berg Balance Scale, Four Square Step Test (FSST), Timed Up and Go test, and the questionnaires 12-item Multiple Sclerosis Walking Scale and Multiple Sclerosis Impact Scale (MSIS). Spearman correlation coefficients were calculated to investigate convergent and discriminant validity. The Mann-Whitney $U$ test was used to analyze differences in FGA scores between individuals reporting falls or not. Results: The mean score of the FGA was 14.7 (SD 5.0, range 5–26). Convergent validity was good with moderate to strong correlation coefficients (rho = 0.34–0.71), lowest for the MSIS physical subscale and highest for the FSST. Discriminant validity was shown with a low correlation coefficient for the MSIS psychological subscale (rho = 0.08). No
significant difference was seen between FGA scores for fallers (mean 14.2, SD 4.3) and nonfallers (mean 15.2, SD 5.6). **Conclusions:** The FGA is a valid measure of dynamic balance and gait for ambulatory persons with MS; however, further studies on prediction of falls are needed.

**References**


(3) IMMEDIATE IMPACT OF A HIP FLEXION ASSIST DEVICE ON SPATIOTEMPORAL PARAMETERS OF GAIT IN INDIVIDUALS WITH MS

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**Background:** Even though assistive devices and orthotics are commonly prescribed to multiple sclerosis (MS) patients with gait disturbance, data regarding their effect on gait pattern are scarce. The Hip Flexion Assist Device (HFAD) was designed to supplement voluntary hip flexion while walking. An uncontrolled longitudinal 12-week pilot study in 21 MS patients
showed statistically significant improvement on several walking performance tests, but spatiotemporal (ST) gait parameters were not assessed. The goal of this study is to assess the immediate effects of the HFAD on ST gait parameters. **Methods:** Data collected during physical therapy visits on 15 patients were extracted from medical records. ST gait parameters were assessed on the GAITRite electronic walkway without and with the HFAD, at comfortable (n = 15) and fast (n = 9) pace. The device was worn on the leg with more severe hip flexor weakness, after fitting by a trained physical therapist. Rest periods were provided to avoid fatigue. Within-group changes were assessed using the paired t test, and effect sizes of change (ES) were computed. **Results:** Although there was improvement in average values with the HFAD for many ST gait parameters at comfortable and fast pace, the only statistically significant differences observed were an increase in step length on the leg wearing the HFAD and an increase in step width on the contralateral leg, at fast pace only (mean change 5.25 cm, P = .02, ES = 0.91; mean change 10.09 cm, P = .03, ES = 1.5, respectively). There was a trend for improvement of velocity at fast pace (mean change 7.0 cm/s, P = .06, ES = 0.72). **Conclusion:** These preliminary results suggest that wearing the HFAD does result in immediate changes in gait pattern at fast pace. Further evaluations should be performed on larger groups of MS patients covering a range of walking disability, after prolonged device use, and compared to other devices.

(4) STRUCTURAL CONNECTIVITY OF PROPRIOCEPTIVE NEURAL PATHWAYS IN MS
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Mobility and balance impairments are a hallmark of multiple sclerosis (MS), affecting nearly half of patients at presentation, resulting in decreased activity participation, falls, injury, and reduced quality of life. A growing body of work suggests that balance impairments in people with early-stage MS are primarily the result of deficits in proprioception, the ability to determine body position in space in the absence of vision. Proprioceptive information from the ankles is the primary sensory feedback used to maintain balance, and central processing of this feedback is critical as evidenced by recent work showing significant associations between balance performance and proprioceptive-related neural activity. We hypothesize that compromised white matter of proprioceptive pathways in MS disrupts the transmission of proprioceptive feedback, leading to declines in balance control and increasing the likelihood of falls and injury. We are using diffusion tensor imaging (DTI) to image the structural connectivity of the conscious and unconscious proprioceptive pathways in MS participants and healthy age-matched controls. Additionally, participants’ proprioceptive acuity (conscious) and compensatory postural adjustments (CPAs; unconscious) are being tested to determine the relationship between structural connectivity of the relevant neural networks and behavior. Data collection is currently in progress; here we present structural connectivity analyses of the relevant neural pathways identified in healthy controls. The conscious pathway comprises connections between the gracile nucleus and the contralateral ventral posterolateral (VPL) nucleus of the thalamus and primary somatosensory cortex (S1). The unconscious pathway is composed of fiber tracts ascending the dorsal corticospinal tract to the fastigial nucleus and anterior lobe of the cerebellum and connecting to the ipsilateral VPL and S1. Results from this work will inform future intervention studies. Successful rehabilitation in people with MS requires clinicians/researchers to identify the explicit deficits in their patients so that intervention approaches can be specific and effective.
Background: Walking and balance impairments are common in people with multiple sclerosis (PwMS). Dalfampridine was approved by the US Food and Drug Administration (FDA) in 2010 to improve walking impairment in PwMS, based on studies demonstrating increased walking speed in drug responders. However, whether dalfampridine affects standing balance is unknown. Thus, the purpose of this analysis was to determine the effects of dalfampridine on standing balance. Methods: This ongoing study randomly assigned 24 PwMS to dalfampridine, 10 mg twice a day, or matched placebo for 12 weeks in a 1:1 fashion. Balance was monitored at baseline, on day 2, and at weeks 4 and 12 after drug initiation. Body-worn, inertial sensors, each of which housed a three-dimensional gyroscope, tri-axial accelerometer, and magnetometer, were used to detect changes in balance. Postural sway was assessed using inertial sensors on the lower back when subjects performed the sensory organization test (SOT) on the Equitest (Neurocom). Study subjects: A total of 86% of the MS subjects had relapsing-remitting disease, and about half (54%) were males. Average MS disease duration was 14.5 years (range 3–30 years). The average Expanded Disability Status Scale (EDSS) score at baseline was 4 (range 2–6.5). Analysis planned: Based on the previous study from our center, we predict that accelerometer-based analysis of spontaneous sway, eg, the “jerk,” which indicates smoothness of the postural sway, etc, may serve as a powerful tool for monitoring the effects of treatment of
balance disorders in subjects with MS. Upon completion of the double-blind, randomized controlled study in August 2013, we will determine whether specific balance measures are improved by dalfampridine and whether specific balance metrics are particularly responsive to this drug.

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Oregon Health and Science University (OHSU) and Dr. Horak have a significant financial interest in and are employees of APDM, a company that may have a commercial interest in the results of this research and technology. This potential institutional and individual conflict has been reviewed and managed by OHSU.

(6) EFFECT OF A SERVICE DOG ON AMBULATION IN MS INDIVIDUALS WITH GAIT DYSFUNCTION

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Background: Walking impairment and inactivity is a primary concern for individuals with multiple sclerosis (MS). In recent years, service animals have become more recognized as productive aids to individuals with disabilities. The Timed 25-Foot Walk (T25FW) has been used as an outcome for medical intervention in gait dysfunction in MS. Objective: To determine whether walking speed in MS individuals with ambulatory dysfunction, but without requiring a
walking aid, improves with the use of a certified service dog as assistance. **Method:** The study cohort included 36 individuals with MS identified as having a gait abnormality secondary to MS but who were able to walk without using any assistive device. The mean age was 52 years, and the mean duration of MS was 14 years. They were asked to perform two T25FW sets, each including an unassisted walk and one with a service dog. The order was reversed for the second set, which was performed after a 15-minute rest period. A paired-sample t test was used to examine the difference between walking with a service dog versus walking without. **Result:** There was a significant difference in the T25FW for individuals who walked with the aid of a service dog compared to individuals walking on their own ($P < .05, P = .014$). **Conclusion:** There was an improvement in walking speed when individuals walked with the aid of a service dog compared to ambulating on their own. This study is the first, to our knowledge, to use a service animal as a way to improve ambulatory dysfunction in MS. These results should encourage additional research in the use of service animals for this and other outcomes of quality of life.

(7) DETECTING CHANGES IN GAIT CHARACTERISTICS DURING A SIX-MINUTE WALK USING WIRELESS TECHNOLOGY IN MS SUBJECTS

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**Objective:** The 6-Minute Walk (6MW) is a measure of gait performance and disability known to differentiate multiple sclerosis (MS) subjects from controls. Current clinical application of the 6MW lacks high-precision measurement tools needed to capture the variety of gait impairment in MS. This study—as part of an ongoing effort to characterize MS gait impairment over the course of the 6MW—adopts wireless inertial sensors as a higher-precision gait measurement tool. Prior work has shown that inertial sensor-based gait analysis separates MS subjects from controls with greater effect size than the traditional outcome measure, gait speed. However, because of the heterogeneous pathology of MS disease, many characteristics of gait impairment vary widely from subject to subject. To better understand the relationship between MS and gait abnormality, we seek to identify subgroups within the MS population that are associated with unique, detectable features of gait impairment. **Methods:** Thirty-seven subjects with MS and 10 control subjects completed a 6MW while wearing high-precision accelerometers and gyroscopes at the wrists, ankles, and waist. Subjects with MS were then examined within two subgroups based on the pyramidal and cerebellar functional system subscores of the Expanded Disability Status Scale (EDSS). Nineteen of these subjects had a pyramidal score of 2 or greater, and 13 had a cerebellar score of 2 or greater. Inspired by clinical observation of subjects with severe gait pathology, we extracted gait features from raw linear acceleration and rotational velocity data, including heel strike amplitude, sacral jerk, measures of stride asymmetry, and rotation in the frontal plane. These features were evaluated by Cohen $d$ metric for their effect size (ES) between the MS groups and the control group. **Results:** In initial analysis for this pilot study, only heel strike angular velocity had a medium ES (0.5742) between MS subjects and controls. Encouragingly, however, we were able to identify several trends among individual subjects within both MS
groups. Trends included greater frontal plane motion in the pyramidal group and greater increase in sacral jerk in the cerebellar group. Further, one MS subject with both cerebellar and pyramidal disability had a profound increase in stride amplitude asymmetry over the course of the walk.

**Discussion:** To better understand gait characteristics across heterogeneous MS pathology, we separated MS subjects into two subgroups based on the pyramidal and cerebellar subscores of the EDSS. Using high-precision wireless inertial sensors, we then identified features unique to each subgroup and not found in controls. Features of interest include heel strike angular velocity, stride amplitude asymmetry, frontal plane motion in the pyramidal group, and sacral jerk in the cerebellar group. Our ongoing work is focused on 1) more precisely identifying subgroups of MS with shared gait characteristics, 2) understanding how these subgroups relate to objective and subjective measures of MS pathology, and 3) identifying additional gait features associated with MS pathology.

(8) SYNERGISTIC EFFECT OF IMPAIRED VIBRATION AND LOWER LIMB KINETICS CONTRIBUTING TO GAIT AND BALANCE LIMITATIONS IN MULTIPLE SCLEROSIS

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**Purpose/Hypothesis:** Cerebellar and dorsal column tissue integrity influences gait and balance functions in persons with multiple sclerosis (PwMS). In this study, we hypothesized that PwMS with combined clinically assessed lower limb vibratory and intralimb kinetics impairments
would have the most pronounced gait and balance limitations. **Number of Subjects:** Thirty-nine PwMS (23 female, 16 male; age 40.8 ± 11.4 years, range 22–62 years; Expanded Disability Status Scale score 3.5 ± 1.7, range 0–6) were divided into subgroups based on vibration perception threshold (VPT) and heel-shin slide (HS) test scores. **Materials and Methods:**

**Groups:** 1) n = 8 impaired VPT (≤4 on the Rydel-Seiffer tuning fork on the first toe interphalangeal joint); 2) n = 4 impaired limb kinetics (≥1 on the Scale of the Assessment and Rating of Ataxia [SARA] HS item); 3) n = 10 impaired VPT and HS; 4) n = 17 normal VPT and HS. Subjects were evaluated on the Timed 25-Foot Walk test (T25FW), 6-Minute Walk test (6MW), Dynamic Gait Index (DGI), Four Square Step Test (FSST), 12-item Multiple Sclerosis Walking Scale (MSWS-12), and Activities Balance Confidence Scale (ABC). **Results:** Kruskal-Wallis and post hoc tests revealed significant differences between groups 3 and 4, respectively, for MSWS-12 (P = .01, Md = 65.5/35.7), FSST (P = .01, Md = 17.0/9.1 s), 6MW (P = .04,Md = 364.2/480.0 m); between groups 3 and 2 for MSWS-12 (P = .01, Md = 65.5/25.0) and 6MW (P = .01, Md = 364.2/561.4 m); and between groups 3 and 1 for 6MW (P = .04, Md = 364.2/517.4 m).

**Conclusions:** The largest deficits were found in the combined group. Group differences were most common between the combined and no impairment groups. The findings suggest a synergist impairment effect on function. **Clinical Relevance:** It is important to test both vibration and kinetic function in the clinical assessment of underlying impairments of gait and balance limitations.

(9) PHYSIOLOGICAL FALL RISK AND DUAL TASK COST OF WALKING

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Background: Individuals with multiple sclerosis (MS) commonly display walking and cognitive impairments. While walking with a simultaneous cognitive task, individuals with MS experience a greater decline in walking performance than healthy controls. This change in performance is termed dual task cost (DTC) and has been associated with fall risk in older adults. Walking and cognitive impairment are independently associated with a history of falls in MS; however, there is conflicting evidence of a link between falls and DTC in this population. Purpose: We examined whether DTC during walking was related to fall risk in persons with MS. Methods: Thirty-three ambulatory persons with MS performed walking tasks with and without a concurrent cognitive task as well as underwent a fall risk assessment. Walking velocities were recorded for all trials and DTC was operationalized as the percent change in velocity from normal walking conditions to dual task walking conditions. Fall risk was quantified using the Physiological Profile Assessment (PPA). A Spearman correlation analysis analyzed the relationship between the walking velocities for both normal and dual task walking as well as DTC of walking with fall risk. Results: The mean DTC of walking for the participants was 11.9% (SD = 12.4%), and PPA fall risk score ranged from −0.15 to 6.4. The correlation analysis revealed a single significant correlation between DTC of walking velocity and fall risk ($r_s = 0.39; P < .05$). Discussion: The findings of this study are the first to illustrate a significant link between DTCs of gait and elevated fall risk in persons with MS. Given the association between falls and cognitive and gait impairment in persons with MS, it is possible that DTC of walking could provide a novel marker of fall incidence in this clinical population.
In persons with multiple sclerosis (PwMS), problems with balance are reported by up to 85% of individuals, but there are few quantitative clinical balance assessment tools available. Use of accelerometry (ACC) to measure postural control during standing would provide a means of assessment previously available only through posturography systems. To date, ACC sway measures have not been validated in PwMS. This study investigated the relationship between postural sway variables calculated from force plate center of pressure (COP) and from ACC time series in PwMS and in healthy controls. Forty PwMS (self-reported Expanded Disability Status Scale [EDSS] score 4.3 ± 1.2) and 20 healthy controls participated. Subjects were outfitted with an MTX Xsens sensor containing three-dimensional accelerometers and three-dimensional gyroscopes mounted on the sacrum (L5 lumbar level). Concurrently, subjects stood on two side-by-side force platforms (one under each foot) with arms crossed, heel-to-heel distance fixed at 10 cm, and eyes open. Within PwMS, correlation coefficients between sway variables from COP and ACC were significant for root mean square (RMS), range, velocity, area, and frequency. Within healthy controls, correlation coefficients between COP and ACC variables were significant for RMS, range, and area. Between groups, RMS, range, velocity, and area were
significantly greater in PwMS for both COP and ACC methods except for ACC velocity.

Interestingly, the correlations between COP and ACC variables were stronger in the MS group (rho = 0.804–0.378) than in healthy controls (rho = 0.642–0.343). Paired tests and ROC analysis indicate that corresponding variables (COP range vs. ACC range) were both able to identify significant differences between groups and that the discriminative ability of corresponding variables in separating PwMS from healthy controls is similar. These results indicate that ACC sway variables could be used to measure sway in subjects with MS and could act as sensitive and quantitative clinical assessment variables.

(11) CONCURRENT VALIDITY OF THE PATIENT-SPECIFIC FUNCTIONAL SCALE AND THE TIMED 25-FOOT WALK TEST IN PEOPLE WITH MULTIPLE SCLEROSIS

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**Background:** Walking is highly important to people with multiple sclerosis (MS) and directly influences participation. The Timed 25-Foot Walk test (T25FW) is considered the best clinical performance measure of walking in people with MS but has not been validated extensively with patient-reported outcomes. The Patient-Specific Functional Scale (PSFS) is a fast and accurate way to measure patient-reported participation, but has never been validated with a physical performance measure. **Purpose:** Determine concurrent validity of the PSFS and T25FW in people with MS. **Methods:** Retrospective chart review from a hospital-based outpatient physical therapy clinic affiliated with a regional MS center. **Inclusion criteria:** Patients with clinically
definite MS who underwent usual care physical therapy and had PSFS and T25FW assessment at evaluation and discharge (n = 17). Exclusion criteria: None. For all participants, the Pearson correlation coefficient was used to analyze the relationship of PSFS and T25FW change scores. Two groups were determined by PSFS change (≥2 points for improvement, <2 points for no improvement) and independent t tests were used to compare T25FW changes between groups. Standard difference of the mean (SDM) was also calculated. Results: A statistically significant inverse correlation was found between changes in PSFS and T25FW ($r = -0.76$, $P < .001$). T25FW improved significantly for subjects who improved on the PSFS (n = 8) compared to those who did not improve on the PSFS (n = 9) ($t = 4.83$, $P < .001$), with a large SDM of 2.35 (95% CI, 1.11–3.58). Conclusions: This report provides early evidence supporting concurrent validity between the PSFS and T25FW, and is consistent with previous evidence supporting the responsiveness of both measures to physical therapy in people with MS. These measures are easily administered and determine meaningful changes in participation and performance. The combined use of the PSFS and T25FW should be considered for people with MS.

(12) COHERENCE ANALYSIS REVEALS ALTERED POSTURAL CONTROL DURING STANDING IN PERSONS WITH MULTIPLE SCLEROSIS

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Background: Persons with multiple sclerosis (PwMS) often complain about reduced balance and have increased sway during quiet standing. However, thus far, no investigations have been
conducted to determine whether PwMS have altered balance strategies while standing. Recently, young healthy adults were found to mainly use an ankle strategy during quiet standing below 1 Hz and a mixed, hip strategy above 1 Hz. Here we investigated balance strategies during quiet standing using a coherence analysis. **Methods:** Eighteen PwMS and 12 healthy controls of similar age participated in the study. Subjects stood quietly for 30 seconds with eyes open (EO) and closed (EC) for three trials in each condition. Acceleration data from the inertial sensors (Xsens) placed on the sacrum (trunk segment) and right ankle (leg segment) were used for this analysis. Coherence was calculated to determine balance strategy: a high coherence was defined as ankle strategy (segment moving together), whereas a low coherence was defined as mixed strategy. **Results:** A significant effect of Group was found for coherence in the EO ($F = 27.58, P < .001$) and the EC ($F = 45.23, P < .001$) conditions in which coherence was lower in PwMS compared to controls in both conditions. There was a significant effect of Frequency for both EO and EC conditions in which coherence decreased as frequency increased in both groups. **Discussion:** We found that in PwMS, coherence is lower compared to controls even at low oscillation frequencies in the EO condition, meaning that PwMS are using a mixed strategy whereas controls are using more of an ankle strategy. In contrast to EO, the EC condition resulted in differences in coherence between groups primarily at the higher frequencies. As frequency increases, coherence in PwMS stays lower than in controls. Thus, visual feedback appears to be able to substitute for delayed and reduced somatosensory feedback at higher frequencies of postural sway.

(13) BALANCE-EXERCISE PROGRAM REDUCED FALLS IN PEOPLE WITH MS

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Falls are common in people with MS (PwMS). The aim was to evaluate the effects of a balance-exercise group program on prospectively reported falls using fall diaries. In addition, activities-specific balance confidence was reported using the ABC scale.\textsuperscript{1,2} \textbf{Methods:} In a multicenter experimental study, a program of 14 60-minute sessions of group exercise (twice a week for 7 weeks) targeting core stability, dual task performance, and sensory strategies was evaluated. The balance exercise program was based on previously published research findings\textsuperscript{3-5} and consensus discussions with physiotherapists specializing in MS and participating in the trial. Measurements were conducted 7 weeks before participation in the balance exercise group, during the intervention period, and then 7 weeks after the completed intervention. The results of those 26 first included PwMS with complete data (mean age 55.5 [SD 10.7] years) are presented. Eight people had relapsing-remitting MS, 14 secondary progressive MS, and 4 primary progressive MS. Six used a walking device indoors, and 23 were female. The Wilcoxon signed rank test and the Pearson chi-square test were used, and the \( P \) value was set at .05. \textbf{Results:} Fifteen (58\%) people reported falls 7 weeks before intervention, compared to 8 (31\%) after (\( P = .004 \)). The number of falls was significantly lower after (mean 1.54, SD 3.2) compared to before (mean 5.88, SD 9.0) intervention (\( P \leq .001 \)). Activity-specific balance confidence remained unchanged (before: mean 56.4, SD 19; after: mean 54.6, SD 18; \( P = .545 \)). \textbf{Conclusion:} The intervention significantly reduced both the number of falls and the proportion of those who fell but did not
alter activities-specific balance confidence. Targeted balance exercise is recommended for those PwMS who are susceptible to the risk of falling.

References


(14) EFFECT OF DALFAMPRIDINE ON GAIT AND BALANCE IN PATIENTS WITH MULTIPLE SCLEROSIS: THE STEADY STUDY

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**Background:** Dalfampridine extended release tablets (D-ER; prolonged-release fampridine in Europe), 10 mg twice daily, improve walking in some patients with multiple sclerosis (MS) as measured by an increase in walking speed. **Objective:** To measure gait and balance changes after D-ER treatment using the NeuroCom SMART™ Balance Master, and to correlate these assessments with established mobility-related measures in MS. **Methods:** STEADY was an open-label, single-center withdrawal study of Timed 25-Foot Walk (T25FW) responders defined as patients with walking speed improvement from off- to on-drug T25FW evaluations. NeuroCom measured multiple gait and balance domains. Evaluations were performed on-drug at screening and 1-week post-screening (baseline; Period-1); at D-ER withdrawal and off-drug, Days 5 and 11 (Period-2); and at D-ER re-initiation and on-drug, Day 15 (Period-3). The primary endpoint was a composite NeuroCom gait score, with balance evaluated if gait results were significant. Secondary endpoints included T25FW, walking distance (2-Minute Walk test [2MW]), and the Berg Balance Scale (BBS). **Results:** Twenty patients (mean age 53.1 years) were enrolled. Overall gait score was significantly better on- than off-drug (least square mean difference 4.04; \( P = .015 \)). There was no effect on overall balance, but progressive improvement was observed across the periods. T25FW, 2MW, and BBS significantly deteriorated after D-ER withdrawal (\( P < .05 \)) and significantly improved on re-initiation (\( P < .05 \)). NeuroCom gait correlated with T25FW speed (\( r = 0.705 \)), 2MW distance (\( r = 0.695 \)), and BBS (\( r = 0.759 \)). Weaker correlations were found for NeuroCom balance with T25FW, 2MW, and BBS. All correlations were significant (\( P < .001 \)). Tolerability profiles were similar on- and off-drug, and were consistent with previous studies. **Conclusions:** Results confirm positive on-versus off-drug effects, suggesting that D-ER has gait benefits beyond improvement of walking
speed, with potential effects on distance, balance, and other walking parameters. There were no new safety signals.

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(15) PHYSIOLOGICAL FACTORS OF GAIT VARIABILITY IN PERSONS WITH MULTIPLE SCLEROSIS

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Objective: To examine the underlying mechanisms of elevated gait variability in persons with multiple sclerosis (MS). Background: Walking impairment is commonly reported by persons with MS. An understudied aspect of walking impairments is gait variability. Gait variability is associated with clinical disability and with various adverse outcomes such as falls in persons with MS. Although persons with MS have greater fluctuations between individual steps compared to healthy controls, the factors underlying gait variability in persons with MS are not clear. Methods: Sixty-eight individuals with MS (mean age = 60.8 ± 7.2 years; female = 52) participated in this investigation. Participants walked down a 30-foot walkway at a comfortable pace twice. The middle 20 feet of the walkway was covered with a 20-foot pressure-sensitive mat. Software (PKMAS™) associated with the walkway allowed for the calculation of intrastep variability of step length, step width, and step time. Participants underwent assessment of proprioception (joint position matching), isometric knee extension strength, and postural sway on
a foam surface. Rank-ordered correlation analysis between metrics of gait variability and physiological function were conducted. **Results:** Step time variability was associated with proprioception \( (r_s = 0.21, P < .05) \), muscle strength \( (r_s = 0.25, P < .05) \), and postural sway \( (r_s = 0.27, P < .05) \). Step length variability was associated with postural sway \( (r_s = 0.33, P < .05) \).

**Conclusion:** Gait variability was related to several physiological mechanisms. These results suggest that gait variability is multifactorial in nature. Future research is warranted to determine whether improvements in underlying physiological mechanisms lead to improvements in gait variability in persons with MS.

(16) CENTER OF PRESSURE TRAJECTORY OF FOOT FALLS IN MULTIPLE SCLEROSIS

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**Background:** Walking impairment is common in persons with multiple sclerosis (MS). Early detection of walking impairments is paramount because it allows earlier intervention. This has led to the examination of novel metrics of gait. Recently, investigations of the center of pressure (COP) while walking were found to be able to distinguish between healthy controls and persons with MS who had mild gait impairment. **Purpose:** This preliminary investigation was conducted to explore whether COP trajectory within individual footfalls is sensitive to various levels of walking impairment in individuals with MS. **Methods:** Thirty-three individuals with MS participated in the investigation (age = 60.8 ± 7.8 years). They were separated into groups based on assistive device use at time of testing (none = 12, cane = 12, walker = 9). Participants self-
reported disability and performed two comfortable pace walking trials down a 30-foot path. The middle 20 feet of the path was covered with a Zeno™ pressure-sensitive walkway that allowed for the measurement of individual footfalls. COP trajectory of individual footfalls was indexed with path efficiency ([Start to End Distance]/[Path Length] × 100) with PKMAS™ software. In order to determine whether walking impairment was related to gait impairment, two statistical tests were conducted: 1) a one-way analysis of variance (ANOVA) with assistive device group as the between-subject factor was conducted on path efficiency; 2) path efficiency was correlated with self-reported disability. **Results:** Participants who used a walker to ambulate had lower path efficiency (mean = 86.8 ± 10.26) than the no assistive device group (mean = 95.3 ± 1.47) (P = .02, d = −1.16). Path efficiency was negatively correlated with self-reported disability (rₚ = −0.45, P < .05). **Conclusion:** COP trajectory within individual footfalls holds promise as an index of gait impairment in persons with MS. Further work testing this parameter is warranted.