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Difference in Dynamic Gait Stability Between Sides in People with Multiple Sclerosis

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1 Introduction

Falls are a significant concern with disastrous consequences among people with MS (PwMS) and frequently happen during locomotor activities, such as walking. Dynamic gait stability, quantified by the kinematic relationship between body's center of mass (COM) and base of support (BOS) [3], is a key risk factor of falls [4]. Although dynamic gait stability has been examined for PwMS [2], no study has investigated if dynamic gait stability behaves differently or similarly between body sides (weak vs. strong) in PwMS. Given that the lower limbs on different body sides could demonstrate differences in strength, range of motion, sensation, and thus the spatiotemporal gait parameters among PwMS [2], dynamic gait stability could be different between sides. A comprehensive examination of dynamic gait stability control in PwMS could provide more useful information for developing fall prevention program for this population.The purpose of this study was to inspect if and to what extent dynamic gait stability control differs between sides in PwMS. We hypothesized that PwMS are more stable on the strong side than the weak side at two transitional gait events: touchdown (TD) and liftoff (LO).

2 Methods

Eight PwMS without other known neurological and musculoskeletal conditions (mean ± standard deviation age: 47.88 ± 11.89 years, body height: 1.64 ± 0.10 m, body mass: 64.09 ± 15.99 kg, Patient Determined Disease Steps: 2.21 ± 0.37 out of 8, disease duration: 12.38 ± 6.63 years) participated in this study after signing an informed consent document approved by the Institutional Review Board. The bilateral isometric knee extensors strength capacity was assessed (Biodex, NY) for each participant. The side with more strength capacity was defined as the strong side and the other was the weak side. Participants then walked along a 14-m walkway at their preferred speed. An 8-camera motion capture system (Vicon, UK) collect their full-body kinematics via 26 reflective markers. The body COM kinematics were computed using gender-dependent segmental inertial parameters based on the filtered marker trajectories [1]. The two components of the COM motion state (i.e., its position and velocity) were calculated relative to the rear of the BOS (i.e. the leading heel) and normalized by foot length (lBOS) and $\sqrt{(g \times bh)}$, respectively, where g represents the gravitational acceleration and bh the body height. Dynamic gait stability was calculated as the shortest distance from the COM motion state to the threshold against backward balance loss [5]. Two characteristic events: the TD and LO of both sides were determined from the foot kinematics. The COM position, velocity, and stability were calculated at both events bilaterally. Paired t-tests were used to compare COM position, velocity, and stability at both events between body sides (weak *vs*. strong). All statistics were performed using SPSS 24.0 (IBM, NY) with a significance level of 0.05.

3 Results and Discussion

A statistical significance was found between body sides at TD in COM position (strong *vs.* weak: -1.11 ± 0.19 *vs*. -1.06 ± 0.21, $p = 0.03$, Fig. 1a). No statistical significance existed in velocity (0.36 ± 0.12

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vs. 0.36 ± 0.13, *p = 0.33*, Fig. 1c), and dynamic gait stability (0.08 ± 0.10 *vs*. 0.09 ± 0.11, *p = 0.12*, Fig. 1e) at TD. Similarly, the COM position (strong *vs*. weak: -0.52 ± 0.24 *vs*. -0.56 ± 0.30, *p = 0.19*, Fig. 1b), velocity (0.36 ± 0.12 *vs*. 0.36 ± 0.13, *p = 0.42*, Fig. 1d), and dynamic gait stability (0.20 ± 0.68 *vs*. 0.20 ± 0.08, *p = 0.19*, Fig. 1e) were comparable between sides at the event of LO.

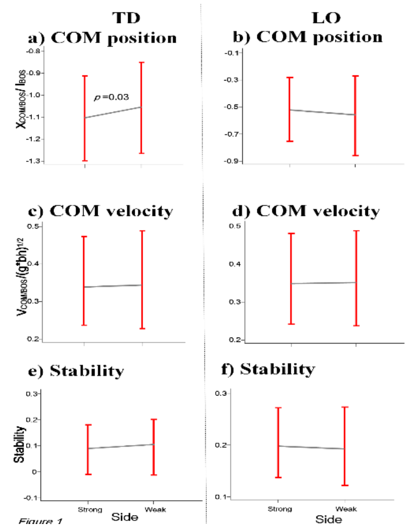

Figure 1. Comparisons of COM position, velocity, and stability between body sides (strong *vs*. weak) at TD and LO.

4 Conclusion

Our results indicated that no side-related difference existed in dynamic stability at both transitional gait events: TD and LO. This finding does not support our hypothesis. However, the difference in COM position at TD was significant (Fig. 1). In addition, COM position at LO was marginal. different, and dynamic stability at both events showed a borderline difference between sides.

The non-significant finding could result from the small sample size. With a larger sample size, this difference could have reached a significant level. Another reason leading to the non-significant finding could be the low disability level, implying small deficits in the mobility and functional performance among our participants. Therefore, it is likely that the side difference in strength, range of motion, and sensation is subtle, which might be insufficient to cause difference in gait biomechanics, and thus dynamic gait stability, between body sides. More studies based on a larger sample size are needed to further examine whether dynamic stability is different between body sides among PwMS.

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