

OBSTACLE CROSSING BEHAVIOR IS AFFECTED BY PARKINSON'S DISEASE

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INTRODUCTION

Postural instability and falls among individuals with idiopathic Parkinson's disease (PD) are common. It is estimated that over two-thirds of community dwelling individuals with PD have fallen at least once in the last year compared to an estimated one third of the healthy population over the age of 65 (Ashburn 2001).

Imbalance and tripping over obstacles during gait were reported as one of the most common causes of falls in older adults (American Geriatrics Society, 2001). Thus, it is not surprising that numerous studies have been devoted to uncovering age-related differences in locomotion during obstacle crossing. Joint kinematics and kinetics of either the trailing (i.e., limb crossing the obstacle last) or leading (i.e., limb crossing the obstacle first) limb as well as balance maintenance during obstacle crossing have been investigated. However, no studies, to our knowledge, have examined whether PD itself modifies gait behavior during obstacle-crossing. This is surprising considering the increased likelihood of falling in this population. Thus, the purpose of this investigation was to examine whether gait behavior while walking over an obstacle is affected by PD.

METHODS

Ten individuals with idiopathic PD (age: 62±9 yrs; height: 172±11 cm; mass: 88±20 kg; Hoehn and Yahr disability 2.4±0.6) and

ten age- and gender-matched healthy control subjects (age: 62±9 yrs; height: 170±8 cm; mass: 77±14 kg) were evaluated. Individuals with PD were tested in the "ON medication" state within 1-1.5 hours of taking their antiparkinson's medication.

Subjects walked barefoot along a 9m walkway at a normal comfortable pace. They were instructed to step over an obstacle placed in the middle of the path of progression and to continue walking. The obstacle was constructed of a wooden dowel (91 cm long and 1.27cm in diameter) supported by two stands which were set so that the dowel height was at 10% of the subject's height. The obstacle was placed between two adjacent force plates (AMTI, Watertown, MA) positioned end to end along the path of motion. Ground reaction forces were collected (1560Hz) from the two force plates embedded level with the walkway surface and halfway down the walkway length. Subjects performed 2 practice trials followed by 5 experimental trials of obstacle crossing.

Kinematic data were collected using an 8-camera optical capture system (Vicon Peak Motion Systems, Oxford UK) that was sampled at 120 Hz. Thirty-nine reflective markers were attached to the subjects in accordance with the Plug-in-gait marker system. Markers were also placed on the ends of the dowel.

For each experimental trial 3 consecutive steps were examined: 1 "approach", 1

“crossing”, and 1 “recovery.” The steps were defined at heel strike based on previous research (Ramachandran, 2006). Average values for the 5 trials for each person were recorded for each of the dependent variables. The following gait parameters were evaluated: step length, step velocity, and step width during each step. Obstacle clearance characteristics that were measured included: vertical clearance over the obstacle for the toe and heel of the lead and trail limbs; horizontal clearance between the obstacle and the toe and heel of the lead limb; and single limb support time while crossing. Center of mass displacements were also evaluated in the anteroposterior, vertical, and medial-lateral directions.

Our primary hypothesis was that differences would be observed in the dependent variables between the 2 participant groups. Three separate (gait parameters, obstacle clearance, center of mass motion) multivariate analysis of variance (MANOVA) were used to test for overall group differences while controlling for type I error. Separate analyses of variance (ANOVAs) were then performed for follow-up testing when appropriate.

RESULTS AND DISCUSSION

None of the subjects came in contact with the obstacle, tripped, nor fell while crossing the obstacle.

The MANOVA detected significant differences between groups for the gait parameters ($F= 9.5$, $p= 0.001$). The individuals with PD walked more slowly and took shorter steps for each step analyzed. The stepping velocity and step length was on average 33% slower and 22% shorter for the individuals with PD compared to the controls. Step width was not different between groups.

The MANOVA also detected significant differences between experimental groups in the obstacle clearance parameters ($F=3.3$, $p= 0.034$). Follow up univariate testing revealed that only time spent in single limb support and horizontal distance between the heel of the trail limb and the obstacle were different. The individuals with PD spent more time in single limb support (17% longer) during obstacle crossing and placed the limb closer to the obstacle when crossing.

COM displacements in the anterior direction were significantly reduced in the individuals with PD when crossing over the obstacle.

Combined these findings of significantly reduced gait speed and step length, closer placement of the limb to the obstacle, and reduced COM motion in the anterior direction indicate that a conservative strategy is adopted by the individuals with PD. However, the larger amount of time spent in single limb support as the lead limb crosses the obstacle increases the chances for balance loss in these individuals.

SUMMARY/CONCLUSIONS

Individuals with PD possess altered gait behavior during obstacle crossing compared to age matched controls. It is likely these differences are a result of a conservative approach to reduce the likelihood of tripping but this behavior may inadvertently increase the balance demands of the task.

REFERENCES

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