Horizontal and vertical foot clearance during obstacle crossing in people with Parkinson's disease; Influence of obstacle height and depth

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Parkinson's disease (PD) is the second most common neurodegenerative disease affecting older adults. Falls are twice as common in people with PD, than in older adults without PD, due to pathology-associated motor and non-motor symptoms. Falls often occur during walking, particularly during complex tasks such as obstacle crossing, which requires stepping patterns to be modified to achieve adequate foot clearance over the obstacle. A reduced foot clearance (horizontal and vertical), relative to the obstacle, may increase the risk of tripping. The aim was to investigate horizontal and vertical foot clearance when crossing obstacles of different height (tall) and depth (long) in people with PD compared to healthy elderly. Thirteen people with PD (69.54±7.72 years, 1.63±0.87m, 70.81±14.27kg, UPDRSIII 26.90±10.98) and fifteen controls (67.85±2.93 years, 1.64±0.96m, 73.29±17.03kg) participated in the study. PD participants were assessed ON dopaminergic medication. Participants negotiated a single obstacle in separate trials (6 obstacle conditions, 2 trials each). Obstacle dimensions for each of the six conditions were as follows: Long obstacles (depth); 15cm, 30cm and 45cm and Tall obstacles (height); 5cm, 15cm and 25cm. Thirty-nine retroreflective markers were used to measure movement (Plug-in-gait model, Vicon®) and marker data were recorded using ten infrared cameras (100Hz). Four retroreflective markers were placed on the obstacle to calculate clearance. The marker data were filtered (5^{th} order low-pass Butterworth, cut off frequency 6Hz) and horizontal and vertical foot clearance was calculated for the toe and heel of the lead and trail crossing steps. Two-way ANOVAs were performed separately for the long and tall obstacles to determine the effect of obstacle size (small (S), medium (M), large (L)) and group (PD vs. Controls). There was a main effect for group indicating that PD participants positioned their trail limb closer to the tall obstacle ($p<0.044$) and achieved a greater vertical clearance compared to controls ($p<0.011$). Both groups increased their vertical clearance (toe and heel) with increased obstacle height for both the lead and trail crossing steps (S<M<L) ($p<0.001$). There were no significant group differences in foot clearance when crossing the long obstacles. Horizontal ($p<0.018$) and vertical ($p<0.001$) foot clearance was greater when obstacles were longer (S<M and S<L). Opting to step closer to the obstacle in favor of achieving a greater clearance over the tall obstacle was a strategy observed in people with PD. There was a graded response with respect to obstacle size, such that greater clearances were observed for both groups when crossing the large (long and tall) obstacles. These preliminary findings indicate that different foot clearance strategies exist depending on group and obstacle size and offer new insight about the challenges encountered in the community and home environment when obstacle characteristics vary greatly.

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