

Diabetic Peripheral neuropathy adversely affects balance during stair ascent and descent

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Grant Acknowledgement: EFSD

Background and aims: Patients with diabetic peripheral neuropathy (DPN) are known to display unsteadiness during walking and as a result be at increased risk for falling. Whilst some studies have found increased postural sway during quiet standing and walking on level ground in patients with DPN, no data exist on objective measures of balance during stair walking. Walking on stairs is one of the most dangerous daily activities in terms of fall risk and this study investigated the underlying mechanisms of unsteadiness in patients with DPN during stair ascent and descent.

Materials and methods: Motion and force data were collected for 22 diabetes patients with DPN (PN; age: 57 ±9.3 years), 40 diabetes patients with no DPN (DM; 57 ±12.8 years), and 32 healthy controls (Ctrl; 50 ±19 years). Movement data was collected using a 10-camera 3D motion analysis system from reflective markers placed at anatomical locations on the body to calculate whole-body centre-of-mass (CoM). The centre-of-pressure (CoP) under the feet was measured using 4 force platforms mounted into the middle of a 7-step staircase, which participants ascended and descended at least 3 times. Balance was quantified by assessing the separation between the centre-of-mass and centre-of-pressure (CoM-CoP separation) in the medial-lateral plane. This parameter was expressed in terms of maximum separation and the variation in separation (standard deviation within 3 trials). Results were analysed using analysis of variation with Tukey post-hoc tests.

Results: During stair ascent the PN group showed significantly higher maximum CoM-CoP separation (mean [SD] PN: 13 [2], DM: 10 [3], Ctrl: 10 [3] cm; $p < 0.01$) and significantly increased variation in CoM-CoP separation (mean [SD] PN: 7 [1], DM: 5 [1], Ctrl: 6 [1] cm; $p < 0.05$) compared to the Ctrl group. During stair descent the PN group again showed significantly higher maximum CoM-CoP separation (mean [SD] PN: 15 [3], DM: 13 [4], Ctrl: 12 [3] cm; $p < 0.05$) and significantly increased variation in CoM-CoP separation (mean [SD] PN: 8 [1], DM: 7 [1], Ctrl: 7 [1] cm; $p < 0.01$) compared to the Ctrl group. The PN group also displayed a significantly wider stance width compared to the Ctrl group during stair descent only (mean [SD] PN: 17 [3], DM: 15 [3], Ctrl: 15 [2] cm; $p < 0.05$). No differences in any variable were observed in the DM group compared to the Ctrl group during stair ascent or descent.

Conclusion: Diabetes patients with peripheral neuropathy display greater extremes in magnitude of medial-lateral sway during stair ascent and descent as well as displaying higher variability during stair ascent and descent. This indicates that patients with DPN have difficulty regulating control of balance during this challenging task. A larger and more variable medial-lateral sway means that patients with DPN are more likely to lose control of balance and experience a fall during what is known to be an activity where the risk of falls is already very high (stair walking).