Shear Forces Applied to the Feet during Walking Act for a Longer Duration in Patients with Diabetic Neuropathy

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Background and aims: High plantar shear pressures are believed to play an important role in the development of diabetic foot ulcers, despite little supporting evidence. In-shoe plantar pressure systems can only measure vertical forces, whilst force platforms allow shear forces to be measured at the foot-ground interface. We investigated whether shear forces at the foot-ground/step interface are elevated in patients with diabetic peripheral neuropathy (DPN) during level ground and stair walking.

Materials and Methods: Data are presented for 94 participants in three groups: patients with DPN (*n*=22), patients with diabetes but no neuropathy (DM; *n*=40) and non-diabetic controls (CTRL; *n*=32). As participants walked at a self-selected speed, ground reaction forces acting on the feet were measured from force platforms embedded into the floor (level walkway) and steps (staircase). Data were analysed using analysis of variance and post-hoc tests.

Results: Peak propulsive shear forces were no different (P>0.05) between groups during stair ascent, but were lower in the DPN compared to the CTRL group during stair descent. The anterior-posterior shear force-time integrals were however, higher in the DPN compared to the CTRL group during both stair ascent (DPN: 0.30, DM: 0.26, CTRL: 0.23 N·s/kg; P<0.01) and stair descent (DPN: 0.41, DM: 0.41, CTRL: 0.33 N·s/kg; P<0.01). During level ground walking, peak propulsive shear forces (DPN: 1.7, DM: 2.0, CTRL: 2.1 N/kg; P<0.01) and anterior-posterior shear force-time integrals (DPN: 0.56, DM: 0.61, CTRL: 0.65 N·s/kg; P<0.05) were lower in the DPN compared to the CTRL group. During level ground and stair walking, the medio-lateral shear force-time integrals were significantly higher in the DPN compared to the CTRL group (P<0.01).

Conclusion: Our results highlight that shear ground reaction forces during level and particularly during stair walking, are applied on the feet of patients with diabetic neuropathy for longer. This longer application of shear forces to the feet may play an

important role in the development of diabetic foot ulcers. Information on the specific area of the foot affected is not known from these measurements alone and warrants further investigation linked together with in-shoe plantar pressure measures.

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