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Foot-Ground Interaction during walking and stair negotiation in people with diabetes and peripheral neuropathy

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Background: People with diabetes and especially those with neuropathy are at high risk of falling during gait. Although walking has been studied in this population, stair negotiation is potentially more dangerous and physically challenging and has not been examined in diabetes patients. The interaction between the foot and the ground/step is an important factor influencing the safety of gait and we therefore aimed to study the kinematics and kinetics of the ankle joint during stair negotiation and walking over level ground. Methods: Here we present pilot data from 3 groups: patients with diabetes and moderate/severe neuropathy (DPN; mean age: 56 years; n=7), patients with diabetes but no/mild neuropathy (D; mean age: 61 years; n=7) and healthy non-diabetic controls (Ctrl; mean age: 50 years; n=7). Participants were examined descending and ascending stairs and walking over level ground in a gait laboratory. Motion analysis and measurement of ground reaction forces enabled capture of kinetic and kinematic data. Analysis of variance was used to test for statistically significant group differences ($P<0.05$). Results: Upon initial step contact while descending stairs, the DPN group (30 deg) plantar flexed their foot significantly less compared to the D (36 deg) and Ctrl (35 deg) groups and both diabetes groups showed clear trends towards lower weight-acceptance ankle joint moments compared to controls. Peak dorsiflexion angle while lowering the body onto the step below was smaller in the DPN group (16 deg) compared to the D (21 deg) and Ctrl (20 deg) groups, indicting stiffness of the plantar flexors. When ascending stairs, the Ctrl group contacted the step with the ankle in dorsiflexion (-2 deg), while the D (0 deg) and DPN (2 deg) groups contacted the step in neutral and plantar flexed positions, respectively, which may increase the likelihood for toe collisions with the step edge in the diabetes groups. No significant differences between the groups were seen in ankle kinematics during walking on level ground, although propulsive peak ankle moments were lower in DPN (1.25 $Nm.kg^{-1}$) and D (1.2 $Nm.kg^{-1}$) groups compared to controls (1.4 $Nm.kg^{-1}$). **Conclusions:** Biomechanical differences at the ankle joint, which may be regarded as salient factors in leading to gait instability and subsequent falls, seem to become more evident between people with diabetes and controls during the more demanding task of stair negotiation.