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Lower Limb Joint Range of Motion and Variability during Stair Negotiation in Patients with Diabetic Peripheral Neuropathy

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Background: Patients with diabetes may experience limitations to joint range of movement especially due to the effects of glycation on lower limb muscles and tendons. Marked alterations to lower limb joint ranges of motion (JRM) and high variability in JRM during gait may increase the likelihood of foot positioning errors, especially during tasks that require accurate foot placements such as stair negotiation. Limitations to JRM and/or increased variability may lead to an increased risk of falling in patients with diabetes. The aim of this study was to investigate lower limb JRM and JRM variability during ascent and descent of stairs. **Methods:** Three participant groups were examined: patients with diabetes and peripheral neuropathy (DPN; mean age: 57 years; *n*=21), patients with diabetes but without neuropathy (DM; mean age: 57 years; *n*=31) and non-diabetic controls (Ctrl; mean age: 53 years; *n*=28). A motion analysis system was used to provide JRM data for the lower limb joints as participants ascended and descended stairs in a gait laboratory. Ankle, knee and hip joint ranges of motion were assessed in three planes across a total of 12 gait cycles. The JRM variability was assessed by calculating the standard deviation across the 12 gait cycles. Analysis of variance was used to test between group differences. **Results:** The DPN group displayed a significantly smaller sagittal plane ankle JRM during stair ascent (DPN: 32.5; DM: 37; Ctrl: 37 deg $P<0.01$) and stair descent (DPN: 50.9; DM: 57.8; Ctrl: 58.8 deg $P<0.01$) compared to the Ctrl group. Hip transverse plane JRM was greater in the DPN group during stair ascent (DPN: 14.3; DM: 12.6; Ctrl: 11.6 deg $P<0.05$) and stair descent (DPN: 20.2; DM: 16; Ctrl: 14.4 deg $P<0.01$) compared to the Ctrl group. Frontal plane JRM was also greater in the DPN group at all lower limb joints during stair ascent and descent compared to the Ctrl group. Despite a trend for increased JRM variability in the DPN group particularly at ankle in the sagittal plane during ascent and descent, these changes did not reach significance due to large within-group variance in the DPN group. **Conclusions:** Our results indicate an altered JRM strategy when ascending and descending stairs in patients with diabetic neuropathy. This strategy includes limited ankle JRM consistent with stiffening of the plantar flexors due to glycation and patients turning sideways as they ascend and descend the stairs. For patients with diabetic neuropathy, turning sideways will compensate for reduced sagittal JRM at the ankle and will ensure as much of their foot fits onto the step to compensate for the absence of sensory feedback upon step contact.
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