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Comparison of muscle activity during walking in subjects with and without diabetic neuropathy

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Abstract

The purpose of this study was to compare muscle activity and joint moments in the lower extremities during walking between subjects with diabetic neuropathy (DN) and control subjects. Tests were performed on nine subjects with DN, and nine age, gender, and weight-matched controls. Onset and cessation times of lower extremity electromyographic (EMG) activity and joint moments were determined. Results demonstrated that subjects with DN had less ankle mobility, slower walking speeds, longer stance phases, and lower peak ankle dorsiflexion, ankle plantar flexion, and knee extension moments than control subjects. Onset times with respect to heel-strike (HS) for the soleus, medial gastrocnemius, and medial hamstring muscles were significantly earlier during the gait cycle (GC) in subjects with DN than in control subjects. The cessation times of soleus, tibialis anterior, vastus medialis, and medial hamstring muscles were significantly prolonged in subjects with DN. Subjects with DN showed more co-contractions of agonist and antagonist muscles at the ankle and knee joints during stance phase compared with control subjects. These gait changes and co-contractions may allow subjects with DN to adopt a safer, more stable gait pattern to compensate for diminished sensory information from the ankle and the foot. The premature activation of soleus and medial gastrocnemius muscles in subjects with DN could be contributing to abnormal forefoot plantar pressure distribution. Additional research is needed to clarify the relationship between the premature activation of triceps surae muscles and the forefoot plantar pressure parameters in subjects with DN.

Keywords: Diabetic neuropathy; Electromyography; Gait analysis; Diabetic ulcers

1. Introduction

In diabetes mellitus, neuropathy can appear as a sensory, autonomic, and motor disorder that is irreversible [1]. Diabetic neuropathy (DN) may disrupt both afferent and efferent pathways of the lower extremity necessary for the maintenance of posture and normal gait [2]. Neuropathy may lead to a disturbance of foot mechanics as expressed in specific gait parameters [3].

Several studies have analyzed gait patterns in patients with DN [3–5]. Mueller et al. [4] report that subjects with DN and a history of plantar ulcers had less ankle mobility, peak ankle plantar moment and power, walking velocity, and stride length than control subjects. Katoulis et al. [3] report that subjects in their experimental group with diabetes and a history of foot ulceration had slower walking speed and smaller maximum knee joint angle when compared with healthy subjects, and with subjects in the diabetic group without foot ulceration. Courtemanche et al. [5] report that patients with DN had a smaller cycle amplitude, cycle speed, and percentage time spent in single support phase than control subjects.

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