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Contribution of Foot Ankle Impairment to Abnormal Foot Loading in Diabetic Patients

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Introduction: Long standing diabetes patients complicated by peripheral neuropathy develop an altered biomechanics of the foot that induce abnormal foot loading. This study was designed to assess the function of the diabetic foot-ankle complex and verify its contribution to these abnormalities.

Methods: 61 long-term diabetic patients with (DN=34) and without (D=27) peripheral neuropathy and 21 controls were examined. Foot ankle complex was measured with a purposely setup equipment with the patient seated and the foot unloaded. Measurements were conducted on 3D ranges of motion, and 3D moments of force obtained during maximal voluntary isometric contractions in different foot position. In addition, patients stepped on a piezo-dynamometric platform and parameters of peak forces and time loading were recorded.

Results: 3D ranges of motion were reduced in D and DN. In the sagittal and trasversal plane respectively, the reduction was 12.3% and 12.6% for D, 23.6% and 21.1% for DN ($p<0.05$). As for muscular function, dorsal-flexing moments were significantly reduced for all groups and foot positions, the highest reduction being 27.4% for D and 36.9% for DN ($p<0.05$). Plantar-flexing moments were significantly reduced with the foot at $+15^\circ$ and $+30^\circ$ (plantar flexion), the latter being the most impairing position (-24.1% for D, -44.6% for DN) ($p<0.05$). Reduction in the other two planes ranged from 15% to 40%. Strong correlation was found between moments of force and peak forces during gait ($R^2=0.906$) and between moments of force and time loading during gait ($R^2=0.972$).

Conclusions: The investigation, performed under strictly controlled conditions, allowed us to highlight functional impairments at the foot-ankle complex even in diabetic patients without neuropathy, strictly correlated with gait parameters. This suggests that other mechanisms besides neuropathy contribute to the altered biomechanics of the foot and abnormal foot loading.