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ORIGINAL ARTICLE

An Apparatus to Quantify Anteroposterior and Mediolateral Shear Reduction in Shoe Insoles

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Abstract

Background:

Many of the physiological changes that lead to diabetic foot ulceration, such as muscle atrophy and skin hardening, are manifested at the foot–ground interface via pressure and shear points. Novel shear-reducing insoles have been developed, but their magnitude of shear stiffness has not yet been compared with regular insoles. The aim of this study was to develop an apparatus that would apply shear force and displacement to an insole's forefoot region, reliably measure deformation, and calculate insole shear stiffness.

Methods:

An apparatus consisting of suspended weights was designed to test the forefoot region of insoles. Three separate regions representing the hallux; the first and second metatarsals; and the third, fourth, and fifth metatarsals were sheared at 20 mm/min for displacements from 0.1 to 1.0 mm in both the anteroposterior and mediolateral directions for two types of insoles (regular and shear reducing).

Results:

Shear reduction was found to be significant for the intervention insoles under all testing conditions. The ratio of a regular insole's effective stiffness and the experimental insole's effective stiffness across forefoot position versus shear direction, gait instance versus shear direction, and forefoot position versus gait instance was 270% ± 79%, 270% ± 96%, and 270% ± 86%, respectively. The apparatus was reliable with an average measured coefficient of variation of 0.034 and 0.069 for the regular and shear-reducing insole, respectively.

Conclusion:

An apparatus consisting of suspended weights resting atop three locations of interest sheared across an insole was demonstrated to be capable of measuring the insole shear stiffness accurately, thus quantifying shear-reducing effects of a new type of insole.

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Abbreviations: (AP) anteroposterior, (CV) coefficient of variation, (DFO) dynamic foot orthosis, (DFU) diabetic foot ulceration, (ML) mediolateral

Keywords: diabetic foot, diabetic foot ulceration, orthotic devices, shear, shear stiffness

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