Biomechanical Evaluation of Therapeutic Footwear in Able-Bodied Persons

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Introduction

Therapeutic footwear and insoles have been widely used in clinical practice in managing foot deformities and ulceration. With an increasing number of new designs of therapeutic footwear on the market each year, both consumers and clinicians are interested in learning their potential biomechanical effects. Among the few studies on therapeutic footwear, majority of them are focused on either plantar pressure or gait kinematics and kinetics. Among some of the most popularly used therapeutic footwear, Orthofeet® (Orthofeet Inc., NJ USA) have some distinct features such as ergonomic sole and tie-less lace design (integrates a lace and straps). However, there lacks scientific evidence showing whether the Orthofeet® therapeutic footwear will offer biomechanical benefits such as reducing the plantar pressure and impact positively on the gait kinematics and kinetics. The purpose of this study was to investigate the effects of two types of Orthofeet® therapeutic footwear in comparison to generic footwear on plantar pressure and lower extremity kinematics and kinetics in a healthy population during walking.

Method

Twenty healthy volunteers (twelve men and eight women; height: 171.5 ± 8.4 cm; body mass: 69.1 ± 10.7 kg; age: 33.1 ± 6.2 yrs) without foot disorders and pains participated and walked at self-paced speed across a walkway three times for each of the four footwear conditions (two therapeutic footwear: orthofeet biofit, orthofeet dress; two generic footwear: Danskin® Now and participants’ own walking shoes). In-shoe plantar pressures were collected using Fscan (Tekscan Inc. MA, USA) and gait kinematics and kinetics in the sagittal plane were obtained using an optical motion analysis system (VICON Inc. Oxford, UK) and two AMTI force plates (American Mechanical Technology, Inc., Watertown, MA, USA). Joint kinematic and kinetic data in the sagittal plane were obtained using Visual3D (C-Motion, Inc. Germantown, MD, USA). Gait kinetics and kinematics were focused on lower extremity in sagittal plane including ankle joint peak dorsiflexion, peak plantar flexion, range of motion, 1st and 2nd peaks of knee flexion, 1st peak flexion and peak extension of hip joint. The peak ankle, knee, and hip joint torques in the sagittal plane were normalized with respect to the body mass and reported in group average and standard deviation. Foot mask included eight anatomical zones and three combined zones (forefoot, mid-foot and hind foot). Within each region of interest, peak pressure and pressure-time integral were obtained. Repeated measures ANOVA was conducted for measured variables.

Results

Therapeutic footwear showed significantly larger ankle dorsiflexion during the late midstance and significantly smaller ankle plantar flexion during push-off than generic shoes. No significant effects of footwear on kinematics were revealed in joints beyond ankle. Similarly, larger ankle plantar flexor torques were shown when wearing therapeutic footwear and orthofeet dress showed significantly higher value compared to Danskin® Now (1.43 ± 0.24 Nm/kg v.s. 1.38 ± 0.24 Nm/kg). Therapeutic footwear altered the plantar pressure distribution with increased peak pressure and pressure-time integral (PTI) under the big toe, slightly reduced peak pressure and PTIs under 1st metatarsal, reduced peak pressure and PTIs under the medial heel. Participants’ own athletic shoes provided slightly distinct outcome measures yet comparable performance when compared to therapeutic footwear.

Discussion and Conclusion

The current study extensively investigated the biomechanical effects of two Orthofeet® therapeutic footwear and two generic footwear (Danskin® Now footwear and participants’ own walking shoes) via evaluating both plantar pressure and gait kinematics and kinetics in the sagittal plane. The outcomes of the study indicated that Orthofeet® therapeutic footwear had detectable biomechanical effects compared to generic footwear, especially the Danskin® Now, such as redistributing the plantar foot pressure, reducing both peak pressure and PTIs especially under the medial heel while increasing peak pressure under the big toe. Participants’ own athletic shoes provided slightly distinct yet comparable outcome measures compared to therapeutic footwear. Our results indicate that therapeutic footwear offer biomechanical benefits over generic shoes and athletic footwear might be considered as a substitute to therapeutic footwear when cost and cosmetics are of concerns.

Clinical Applications

The current study had laid down some pilot work for future clinical trials focusing on evaluating long-term effects of the Orthofeet® therapeutic footwear. In addition, the outcomes of the study might be useful and helpful for both clinical practitioners and consumers when prescribing/selecting therapeutic footwear.

References