

Foot Orthosis Could Improve Elderly Balance and Gait Control by Changing Plantar Mechanical Stimulations

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BACKGROUND

Plantar sensory input is a crucial component of proprioceptive system, which is important for maintaining balance and gait control. Foot orthoses with arch supports, metatarsal pads, and heel cups are traditionally prescribed to correct/compensate foot deformity and relieve foot pain in patients. It was reported that upon achieving these therapeutic functions, the body balance could also be enhanced [1]. However, the underlying mechanism of such balance improvement and the effect of foot orthoses on dynamic balance and gait in healthy adults without foot pain/deformity remained unclear.

In this study, we applied custom-fitted foot orthoses with arch supports, metatarsal pads and heel cups in elderly people. The gait variability decreased while using them, suggesting that they were effective in improving elderly balance and gait control.

AIM

To identify the underlying mechanism of balance improvement upon using foot orthosis (FO) by investigating the relationship between plantar mechanical stimulations and dynamic balance in healthy older adults without foot pain or deformity.

METHODS

FOs with medial arch supports, metatarsal pads and heel cups were provided and fitted for healthy older adults by a Certified Orthotist. Subjects then performed over-ground walking while wearing

1) *Flat insoles only (control),*

2) *FOs with arch supports, metatarsal pads & heel cups.*

The sequence of 2 experimental conditions was randomized, and each condition was repeated 3 times consecutively. Commercially available flat insoles and pads (Foot Specialist Footcare & Products Co. Ltd, HK) were made of medium firm (15-20 Shore A Hardness) ethylene-vinyl acetate (EVA). An in-shoe plantar pressure measurement system (PedarTM, novel GmbH, Munich, DE) was used to measure subject's plantar pressure distribution and gait parameters in 2 experimental conditions during walking. The variability of gait parameters was calculated.



Fig.1: Design of the Foot Orthosis

RESULTS

Four healthy male older adults (age 72 ± 4.7 years, height 166.7 ± 29.3 cm, and weight 73.8 ± 4.1 kg) without foot pain/deformity participated in this study. The foot orthosis re-distributed plantar pressure at metatarsal heads, lateral foot and heel to the medial longitudinal arch, metatarsal shafts and margin of the heel (Fig.2).

The contact area between foot and support surface also increased during walking while wearing custom-fitted foot orthosis as compared to wearing flat insoles (Fig.2). The variability of contact area, maximum ground reaction force, and peak plantar pressure during walking decreased while wearing foot orthosis in participants, indicating reduced gait variability

(Fig.3). Subjects also verbally reported that the comfortableness while wearing foot orthosis was higher than that of wearing flat insoles.

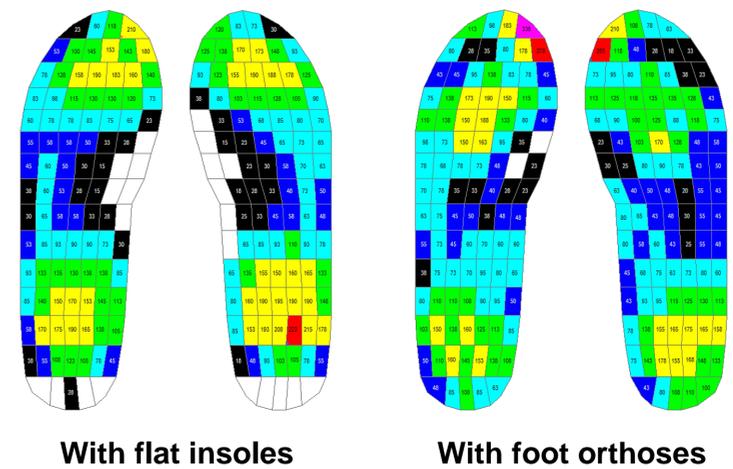


Fig. 2: Example of an Elderly Subject's Plantar Pressure Distribution During Walking in 2 Experimental Conditions

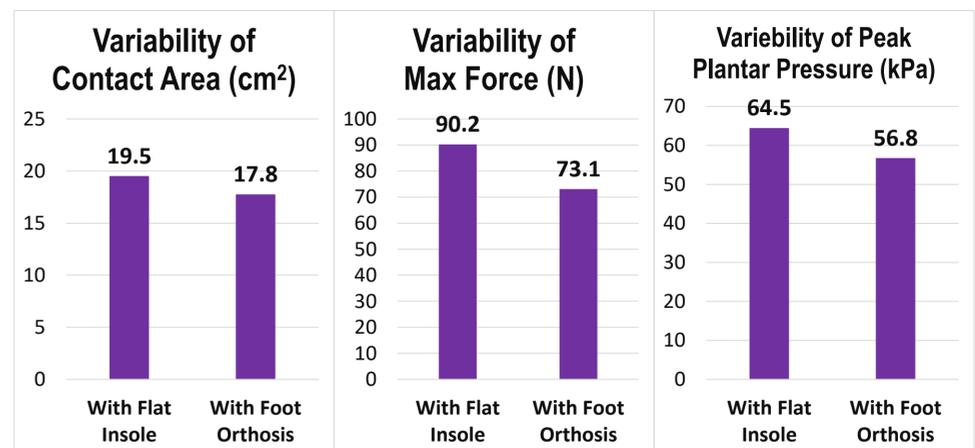


Fig. 3: Effect of Flat Insoles & Custom-fitted Foot Orthoses on Gait Variability in Healthy Older Adults (N=4)

DISCUSSION

Reduced gait variability is associated with improved dynamic balance performance and reduced risk of falls in older adults. In this study, foot orthosis improved dynamic balance and gait control by changing mechanical stimulations at plantar foot. More specifically, foot orthosis re-distributed plantar pressure to the medial longitudinal arch, metatarsal shafts and margin of the heel, where with higher sensitivity to mechanical stimulations [2]; and enlarged the contact area between plantar foot and support surface. The changed plantar mechanical stimulations enhanced sensory input at plantar surface of foot, which consequently improved dynamic balance and gait performance in healthy older adults.

CONCLUSION

This study revealed that foot orthoses with arch supports, metatarsal pads, and heel cups could improve dynamic balance and gait control in healthy older adults without foot pain or deformity, and further provided evidence about the underlying mechanism of balance and gait improvement. This potentially provided a cost-effective approach to reduce risk of falls and inspired future research in this field.

REFERENCES

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