INTRODUCTION

Falls are the third leading cause of unintentional death in homes and communities in the United States, causing 27,800 fatalities in 2012 [1]. The ability to maintain proper postural control is an essential part of activities of daily living (ADLs). However, recent types of alternative footwear may be placing the body’s postural control system at an increased risk for perturbations to equilibrium and subsequent falls. The purpose of this study was to examine the effects of three forms of alternative footwear (thong style flip-flops (FF), clog style Crocs® (CC), and Vibram® Five-Fingers (MIN)) on postural control.

METHODS

Eighteen healthy male adults (age: 22.9±2.88 years; height: 179±6.0 cm; mass: 81.3±8.8 kg) with no history of neuro-musculoskeletal disorders participated in this study. Static balance measures were recorded using the six conditions of the Neurocom® sensory organization test (SOT) [eyes open (EO), eyes closed (EC), eyes open with sway referenced vision (EOSRV), eyes open with sway referenced support, (EOSRP), eyes closed with sway referenced support (ECSRP), and eyes open with sway referenced vision and support (EOSRV)]. Surface electromyography (EMG) signals were recorded from the right leg musculature: tibialis anterior (TA), and medial gastrocnemius (MG). The EMG signals were recorded using silver/silver chloride monopolar surface electrodes. The ground electrode was placed on the tibial plateau. The EMG was recorded using Noraxon® MyoResearch software (Noraxon U.S.A. Inc. Scottsdale, AZ.). Raw EMG data were collected at 1,500 Hz, Band-pass filtered (20-250Hz) and rectified prior to analysis. Post acclimatization, participants performed isometric MVC of plantar flexion and dorsiflexion, preceding and after a one-mile self-controlled walk on a treadmill. Muscle Co-contraction index (CCI) (operationally defined as the simultaneous activation of two muscles) was calculated based on the ratio of the EMG activity of antagonist/agonist muscle pairs of the lower leg (TA/MG) using the following equation [2],

$$\text{CCI} = \frac{\text{EMGS}}{\text{EMGL}} \times (\text{LowerEMG} + \text{HigherEMG})$$

where EMGS was the level of activity in the less active muscle, and EMGL was the level of activity in the more active muscle. This ratio was multiplied by the sum of the activity found in the two muscles. This method has been used because it provides an estimate of the relative activation of the pair of muscles as well as the magnitude of the co-contraction. Results were analyzed in SPSS with a predetermined alpha level of 0.05 using a 2 x 3 [2 time measures (pre, post) x three footwear types (FF, CC, MIN)] repeated measures analysis of variance (ANOVA) for each of the SOT conditions. Pairwise comparisons with a Bonferroni correction were used to identify post-hoc differences if interaction or main effect significance were found. If at any point during analysis there was a violation of Mauchly’s test of sphericity, a Greenhouse-Geisser correction was used to determine significance.
RESULTS

There is evidence of a significant interaction between footwear and time for CCI in the EOSRVP condition (F(1.607, 27.322) = 3.684, p = 0.047) (Figure 2). Moreover, plotting of the results suggests a potential reverse interaction, follow-up analyses using simple effects were conducted in an attempt to understand the nature of this interaction. Analyses showed that following the one mile walk, the MIN showed significantly greater CCI than the FF (F(2,16) = 7.002), p = 0.007) (Figure 3).

DISCUSSION

Previous literature has suggested that when proprioceptive feedback at the ankle becomes less reliable due to age related effects, there is an adoption of a new co-contraction strategy for maintaining postural stability [3]. This study adds to this notion, and suggests that different footwear characteristics could potentially cause a fatiguing effect, and decline in proprioception at the ankle joint after a one-mile walk. This potential fatigue and shift in strategy may be explained in part by the increase in CCI observed currently, and may be exacerbated when other sensory information is also unreliable. This stiffening of the ankle joint, as opposed to relying on multiple sensory sources, may pose more of a threat to the individual’s ability to stay stable, and subsequently lead to greater risk of a loss of balance and fall.

REFERENCES


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