FIVE-TOED SOCKS DECREASE STATIC POSTURAL CONTROL AMONG HEALTHY INDIVIDUALS AS MEASURED WITH TIME-TO-BOUNDARY ANALYSIS

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INTRODUCTION

Receiving accurate sensory information is critical for effective motor control during any physical activity. It is especially necessary during dynamic sports activities that require stable standing and accurate ball control, such as baseball, golf and tennis. Orthotics and ankle braces have been believed to enhance the proprioceptive [1] and cutaneous [2] afferent inputs to the central nervous system (CNS); assumedly generating improved efferent inputs for enhanced motor control. While orthotics and ankle braces are commonly used for pathological conditions, such as foot and ankle injuries, a unique pair of athletic socks called five-toed socks has become popular in Japan for healthy active individuals marketed to enhance their athletic ability by increasing postural stability.

There are claims that the five-toed socks improve postural control by separating the toes, potentially increasing the proprioceptive and cutaneous inputs to the CNS, thereby enhancing the perception of the ground and provide a better grip. While the five-toed socks are becoming more popular in Japan, no scientific research has been performed to examine these theories or study the effectiveness of the socks. Therefore, the purpose of this study was to assess the effect of the five-toed socks on static postural control during single-limb balance tests with eyes open and closed.

METHODS

Twenty healthy subjects (11 males, 9 females; 25.5±2.6yrs; 170.8±10.3cm; 74.0±14.3kg) were asked to complete three testing sessions, separated by approximately one week, to measure static postural control. The subjects were tested under three conditions: wearing five-toed socks, wearing regular socks, and wearing no socks (Figure 1). For each condition, static postural control was assessed on a force plate (model 4060NC; Bertec Corp Inc., Columbus, OH) with the subject in a single-limb stance with their hands on their iliac crests, with eyes open (EO) and eyes closed (EC). During the EO trial, subjects were instructed to focus their vision on a large "X" on the wall 3.5 m in front of them and 1.5 m from the floor. The subjects were instructed to keep the non-test limb off the ground in a comfortable position without the limb touching the ground. The test limb was determined as the limb the subject would choose to stand on while kicking a ball. The subjects were instructed to stand as still as possible for 15 seconds. If the subjects hopped on the test limb or touched the ground with the non-test limb, the trial was discarded and repeated. Center of pressure (COP) data were sampled at 50Hz. The subjects completed three 15-second trials with a one-minute rest between trials. Sock conditions were randomized.

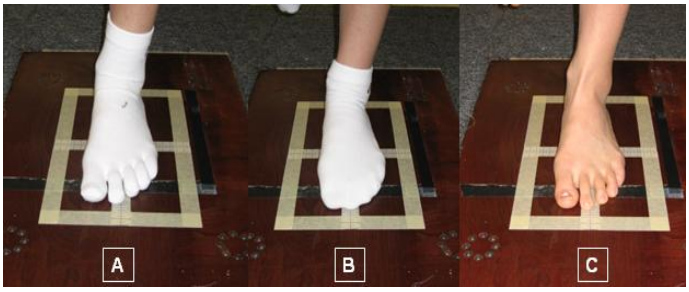

Figure 1: Sock Conditions with single-limb balance tests. A) Five-toed sock condition, B) Regular sock condition, and C) No sock condition.

For each condition, the COP data were averaged for the three test trials, both for EO and for EC trials. The Motion Monitor software (Innovative Sports Training, Inc., Chicago, IL) collected COP data during the single-limb balance testing. MATLAB software (The Mathworks Inc., Natick, MA) was utilized to calculate the Time-to-Boundary (TTB) variables in both the anteroposterior (TTBAP) and mediolateral (TTBML) directions.

The TTB dependent variables, calculated for TTBAP and TTBML separately for EO and EC trials, were the TTB absolute minimum and mean of the TTB minima [3,4]. The independent variable was sock conditions (wearing five-toed socks, wearing regular socks, and wearing no socks). For each dependent variable, a one-way repeated measures ANOVA was performed. Significance was set a priori at $p<0.05$.

RESULTS and DISCUSSION

The five-toed sock condition showed significantly lower TTB values than the no sock condition in the TTBML absolute minimum samples during EO trials ($F_{2,17}$ =4.075; P=0.025) (Figure 2a) and the mean of the TTBML minima samples during EC trials ($F_{2,17}$ =3.919; P=0.048) (Figure 2b), indicating that the five-toed condition was associated with decreased static postural stability when compared to the no sock condition. There were no other significant differences among the sock conditions in either TTBAP or TTBML directions.

The current study demonstrated that the five-toed socks did not improve static postural control among healthy individuals in both anteroposterior and mediolateral directions during EO and EC trials, measured with TTB analysis. Further, in the TTBML absolute minimum during EO trials and the mean of the TTBML minima during EC trials, the five-toed sock condition seemed to impair the postural control when compared to the no sock condition, contrasting the claims that are associated with these socks.

With the five toed-sock condition, individually wrapped toes potentially increase proprioceptive and cutaneous inputs by enhancing tactile sensations and providing pressure to the skin between the toes. However, it is possible that most of the subjects have not experienced this enhanced sensation around the toes before, and this novel sensation may have interrupted the concentration of the subjects during the single-limb balance testing. Future study should include at least a one week adaptation period for subjects to become accustomed to the enhanced sensation around the toes before the data collection is conducted. Additionally, assessing static postural control may not be the most sensitive or applicable measure of the effectiveness of five-toed socks therefore investigation using measures of dynamic postural control may be warranted. Future study also should include comparisons between healthy and pathological conditions such as chronic ankle instability.

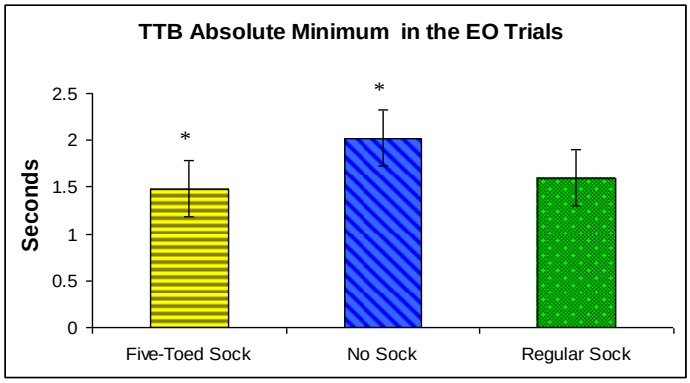

Figure 2a: TTBML absolute minimum in the EO trails ($F_{2,17}$ =4.075; P=0.025).

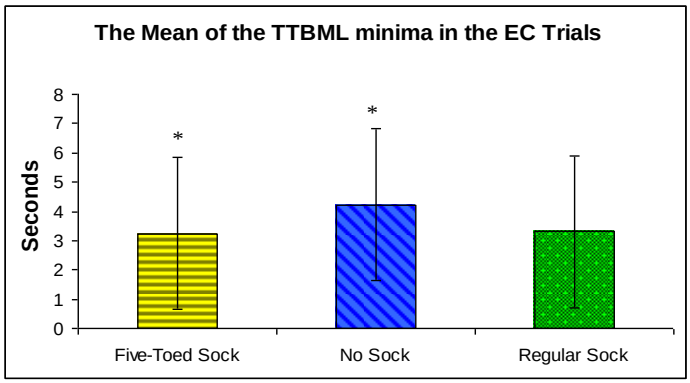

Figure 2b: The mean of the TTBML minima in the EC trials ($F_{2,17}$ =3.919; P=0.048).

CONCLUSION

Single-limb balance testing using measures of TTB revealed that the five-toed sock condition negatively influenced static postural control when compared to the no sock condition among healthy individuals. Further study should include the adaptation period for subjects to become used to the enhanced sensations around the toes before the data collection is conducted.

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