EFFECT OF FOOTWEAR ON BALANCE

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INTRODUCTION

Barefoot and minimal footwear running have become increasingly popular. Barefoot advocates claim that running injuries may be reduced when running in little or no footwear. It has been suggested that this is due, in part, to improved postural stability when shoes are shed, as static and dynamic balance depends on cutaneous and proprioceptive inputs from the feet. Shinohara and Gribble [1] studied balance with 5-toed socks compared to conventional socks and bare feet. They used the time-to-boundary method to assess standing single-leg balance. They found that static balance was compromised in both sock conditions.

Running is a dynamic activity comprised of sequential, single leg landings. If single leg stance balance can be influenced by socks, it is possible that dynamic stability may be compromised by footwear. Therefore, the purpose of this study was to compare measures of dynamic stability during single leg landings across three footwear conditions. We expected that balance would significantly improve as footwear was reduced due to more accurate, unfiltered cutaneous inputs from the foot. Specifically, we hypothesized that balance would be worst in running shoes, better in minimal footwear and best when barefoot.

METHODS

Eighteen healthy subjects (14 male, 4 female) participated in the study. Subjects were free of injury at the time of the study. All were habitual wearers of Vibram Five-Fingers shoes. Data were collected in a single visit to the lab by each subject, in three footwear conditions: barefoot (BF), wearing their own Vibram Five-Fingers (V5), and wearing Nike Pegasus running shoes (RS), supplied by the investigators, as shown in Fig.1 The footwear order was randomized across participants. Dynamic balance was assessed by a jump landing protocol. Each subject balanced briefly on their dominant (preferred for kicking) leg on a 10 cm high platform positioned 70 cm from the edge of a force plate. They then jumped, with eyes open, onto the center of the force plate, landing on the non-dominant leg, typically used for stability. Subjects were instructed to stand quietly and motionless on the landing leg for 10 seconds after landing. There was a rest period between jumps. Force plate data were collected at 1000 Hz during and for 10 seconds after landing. Each subject completed 5 jumps with each type of footwear, for a total of 15 jumps.

Figure 1. Dynamic balance was assessed in bare feet, Vibram Five Fingers, and Nike Pegasus running shoes.

The medial-lateral, anterior-posterior, and vertical components, and the total dynamic postural stability index, were computed for each landing, using a three-second window beginning at the time of landing [3]. Specifically, we computed the square root of the mean squared deviation of force from the baseline value for three seconds beginning at the time of landing, as shown in Figure 2. The baseline value was zero for anterior-posterior and medial-lateral stability indices (APSI and MLSI), and was equal to body weight for the vertical stability index

(VSI). The total dynamic postural stability index (DPSI) was computed as

$$DPSI = \sqrt{APSI^2 + MLSI^2 + VSI^2} \ .$$

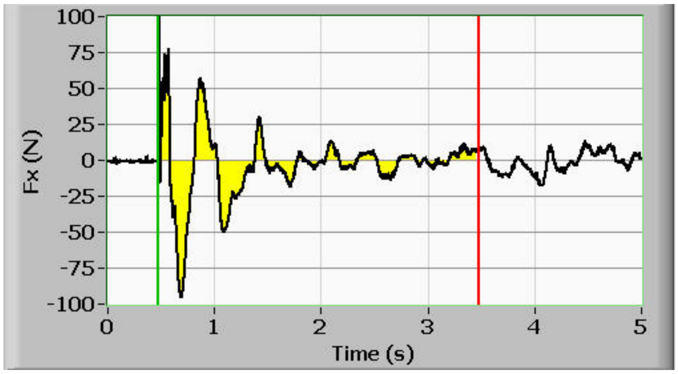

Figure 2: MLSI was computed as the square root of the mean squared medial-lateral force, for three seconds after landing. This time window is shown by the shaded region between the green and red cursors, in the plot of medial-lateral force above. APSI and VSI were computed similarly.

APSI, MLSI, VSI, and DPSI were computed for five jump landings in each individual in each type of footwear. One way analysis of variance with repeated measures was used to test the hypothesis that dynamic postural stability was affected by the type of footwear. Pairwise post-hoc testing was done with the Tukey test.

RESULTS AND DISCUSSION

Mean values, ± standard error of the mean of all four indices, are shown in Table 1. The medial-lateral, vertical, and total stability indices were significantly different between conditions (ANOVA, $p<0.05$). A strong trend was seen in the anterior-posterior stability index ($p=0.057$). Therefore, post-hoc pairwise tests were conducted on all variables. Results indicated that APSI, MLSI, VSI, and DPSI were all significantly lower (Tukey test, $p<0.05$) in bare feet than in standard running shoes. In addition, MLSI was significantly lower in BF versus V5 condition.

Our results support those of Shinohara and Gribble who found that static balance was best in bare feet [1]. For three of the four variables, instability increased between BF and V5, and between V5 and RS. This is likely due to the increasing filtering of sensory input that results from additional material between the foot and the ground. It is interesting to note that DPSI, representing the composite stability measure, exhibited the greatest differences between footwear conditions.

	Index			
Footwear	APSI	MLSI	VSI	DPSI
Barefoot (BF)	0.019 ±0.001	0.144 ±0.003	0.212 ±0.009	0.258 ±0.008
Vibram Five Fingers (V5)	0.021 ±0.001	0.148 ±0.003	0.223 ±0.011	0.269 ±0.010
Standard Running Shoes (RS)	0.022 ±0.001	0.147 ±0.002	0.227 ±0.009	0.272 ±0.009
p (ANOVA)	0.057	0.014	0.039	0.023
Significant pairwise differences	BF<RS	BF<V5, BF<RS	BF<RS	BF<RS

Table 1: Dynamic postural stability indices in different types of footwear. Mean ± SEM. n=18.

CONCLUSIONS

The results of this study indicate that dynamic balance assessed during a single-leg jump landing task is better in bare feet than in standard running shoes, and is not significantly different between Vibrams and standard running shoes. These results are consistent with the hypothesis that filtering or masking of sensory input by footwear can affect dynamic postural stability.

REFERENCES

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