DEVELOPMENT OF A NOVEL BAREFOOT TORSIONAL FLEXIBILITY DEVICE: A PILOT STUDY

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INTRODUCTION

A novel instrument was developed to assess the torsional flexibility of the human barefoot to establish a common basis for comparison of the flexibility properties of foot wear and bare feet. Data was collected on the left foot of five subjects, with each subject being tested in weight bearing and non-weight bearing conditions. Torsional flexibility data was also collected for the Arizona Soft Birkenstock® sandal model. The comparison between the barefoot and sandal torsional flexibilities was made to ascertain differences between man-made shoe gear and man.

METHODS

The Barefoot Torsional Flexibility Device mechanically grounded the heel while the forefoot was positioned on a plate that was rotated about the longitudinal axis of the foot (Figure 1). The goal was to measure the maximum moment and anglular excursion of the foot when it was loaded in inversion and eversion. A torque was applied to each foot in inversion and eversion, cycling three times for each of the three trials collected. Only the inversion segment of each cycle was analyzed for this study, to simulate in vivo loading during propulsion. The sandal flexibilities were quantified with an Instron 4201 structural testing machine (*sampling rate = 20Hz*). Each sandal (size matched for a given subject) was loaded in inversion with the heel mechanically grounded.

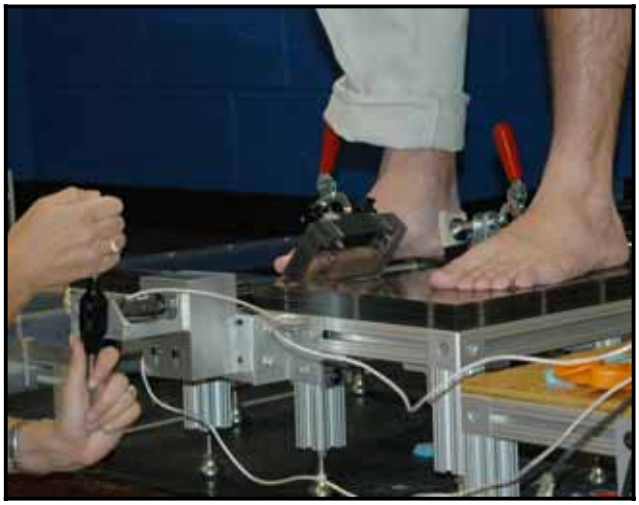

Figure 1: A subject's foot was loaded in inversion using the proposed Barefoot Torsional Flexibility Device.

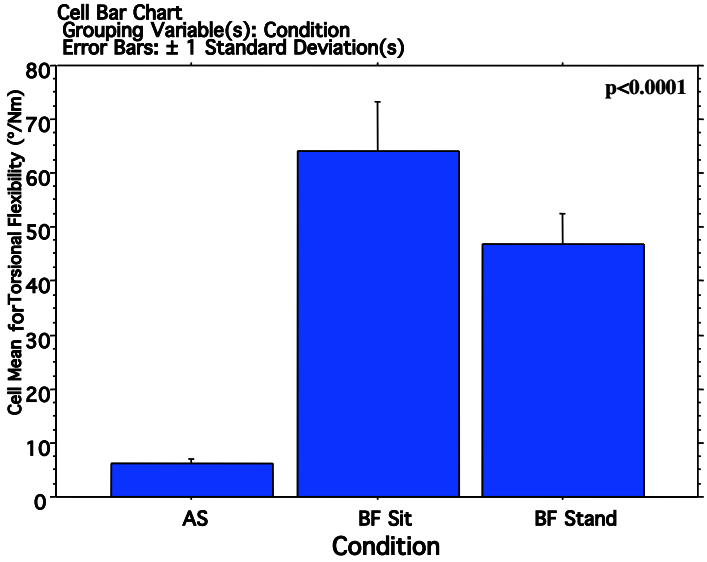

Figure 2: Mean Torsional Flexibilities for all subjects, across all conditions.

RESULTS AND DISCUSSION

The Arizona Soft sandal had the lowest torsional flexibility (i.e. was the most stiff). Barefoot Torsional Flexibility was much higher, with non-weight bearing being the least stiff. A mixed effects analysis of variance (ANOVA) was used to test statistical significance in the three conditions. All of the torsional flexibility conditions were statistically different, the interaction between condition and subject was significant, and the relationship between subjects was not significant. A Bonferroni-Dunn post-hoc analysis was performed and all three conditions were significantly different ($p<0.0001$) from each other. Intra-class Correlation Coefficients (ICC(2,1)) demostrated that the Seated Barefoot Torsional Flexibility (ICC=0.75) and Sandal Torsional Flexibility (ICC=0.99) tests were reliable. Standing Barefoot Torsional Flexibility had a lower reliability (ICC=0.45), which could be a result of non-stationary active contractile processes (i.e. muscles firing during standing).

CONCLUSIONS

The lower flexibility of sandals compared to human bare feet indicate that sandals are likely to modify the function of feet. Because sandals are stiffer than feet, pedal movements may be restricted compared to that of barefoot. Further studies are needed to determine if, the structure of the sandal imposes a change in the function of feet during gait and posture.

REFERENCES

1. Stacoff, A., et al., Med Sci Sports Exerc, 23(4), 1991.