DYNAMIC ANKLE STIFFNESS AND ANKLE WORK IN HIGH- COMPARED TO LOW-ARCHEHD ATHLETES DURING BAREFOOT RUNNING

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INTRODUCTION

Individuals with mal-alignment or aberrant mechanics of the foot and ankle have been demonstrated to have a greater propensity of lower extremity injury [1]. Research has shown that low-arched individuals (LA) experience soft-tissue injuries to the medial aspect of the lower extremity while high-arched individuals (HA) experience bony injuries to the lateral aspect of the lower extremity [2]. It is suspected that a potential underlying mechanism for these unique injury patterns pertains to the role of the medial longitudinal arch in load attenuation. However, it has also been demonstrated that LA feet are significantly less stiff than normal and HA feet [3]. A foot that exhibits reduced stiffness may be a less effective lever for the transfer of muscle force to the ground during eccentric contraction associated with load attenuation and concentric contraction associated with propulsion.

Therefore, the purpose of this study was to examine the effect of foot type on dynamic ankle joint stiffness and ankle work in the braking versus propulsive phases of stance phase in running. It was hypothesized that low-arched individuals would exhibit significantly smaller dynamic ankle joint stiffness values and greater ankle joint work during the propulsive phase of running.

METHODS

Ten high- and 10 low-arched recreational athletes were recruited from a larger study. Arch height index [4] was used to classify participants as HA or LA (HA: AHI>0.377; LA: AHI<0.290). All participants performed five successful barefoot running trials at a self-selected pace while ground reaction forces (960 Hz, AMTI, Watertown, MA) and three-dimensional kinematics (480 Hz, 6-camera, Vicon, Oxford, UK) were recorded simultaneously. Data were filtered using a fourth order Butterworth filter with cutoff frequencies of 10 Hz and 50 Hz for kinematic and ground reaction force data, respectively. Visual 3D (C-Motion, Inc., Rockville, MD) was used to calculate ankle joint kinematics and kinetics.

Dynamic ankle joint stiffness was quantified as slope of the ankle joint angle-moment plot during the braking portion of the stance phase. Ankle joint work was calculated as the ankle moment integrated with respect to ankle position during the total stance phase as well as the braking and propulsive phases of stance. A Student’s t-test was used to compare mean slopes between the high- and low-arched groups while a 2 x 3 group by phase repeated measures ANOVA was used to determine significant differences in ankle joint work variables.

RESULTS AND DISCUSSION

High-arched individuals exhibited significantly greater stiffness values
compared to their low-arched counterparts \((p=0.021)\).

**Figure 1.** Dynamic ankle joint stiffness values in HA compared to LA athletes. * denotes significant difference between HA and LA athletes.

These data demonstrate that differences in running kinetics exist in both the braking and propulsive phases of stance during running. The observed differences in dynamic ankle joint stiffness suggest that HA athletes attenuate load over a shorter period of time compared to their LA counterparts. Further, the ankle work data presented in this study demonstrate that HA athletes require reduced net and propulsive work at the ankle during a running task with similar mechanical demand. The increased muscular demand associated with the LA foot is a potential injury mechanism that should be further studied.

**CONCLUSIONS**

The findings of this study demonstrate differences in ankle joint mechanics during the load attenuation and propulsive portions of the stance phase of running. These differences may result in the unique injury patterns experienced by these two functionally different groups. Further research investigations may pertain to the efficacy of the foot as a mechanical lever during the stance phase of walking and running in these two groups.

**REFERENCES**