EXAMINATION OF FOOT STRIKE PATTERNS AND ANKLE MUSCLE STRENGTH

Christopher Gronseth¹, JJ Hannigan¹, Jim Becker¹, and Li-Shan Chou¹
¹Motion Analysis Laboratory, Department of Human Physiology, University of Oregon, Eugene, OR, USA
email: chou@uoregon.edu, web: http://biomechanics.uoregon.edu/MAL/index.html

INTRODUCTION
Rising popularity of the minimalist shoe, and its associated anteriorly-directed foot strike pattern [1], has initiated debates about the ideal foot strike position in running. Previous studies have shown increased gastrocnemius activity when running with a forefoot strike pattern (FFS), which may have injury implications [2]. Similarly, Daoud et al. found that individuals with a rearfoot strike (RFS) have approximately twice the injury rate as runners with a FFS [3].

Because of the implications to injury, this study chose to investigate ankle strength differences between individuals displaying a forefoot or midfoot strike pattern and a rearfoot strike pattern. It was hypothesized that forefoot and midfoot strikers would display increased plantarflexion strength compared to rearfoot strikers, while rearfoot strikers would display increased dorsiflexion strength compared to forefoot and midfoot strikers.

METHODS
Subjects were retrospectively selected from an existing database at the University of Oregon Motion Analysis Laboratory. 25 subjects met the following inclusion criteria: logging a minimum of 20 miles of running per week, being injury-free at the time of testing, displaying a consistent foot strike pattern, and participating in the ankle strength assessment.

Reflective markers were placed on subjects who ran continuous overground laps of 40 meters in the laboratory at self-selected training speeds. A 10-camera motion capture system (Motion Analysis Corp.) collected whole body kinematics at 200 Hz. Foot strike indices (FSI) were calculated for each limb (n=50) using center of pressure data obtained from three AMTI (Advanced Mechanical Technology, Inc.) force plates located in series. Foot strike was classified into rearfoot strike (RFS), FSI = 0-33%; midfoot strike (MFS), FSI = 34-67%, and forefoot strike (FFS), FSI = 67-100% [5]. MFS and FFS were grouped together for analysis due to small sample size and biomechanical similarities between the two groups. This follows a similar subject alignment of Willson et al., who categorized runners into RFS and non-rearfoot strikers [6].

Upon completion of the running protocol, isometric ankle strength measurements were collected on a Biodex System 3 Dynamometer (Biodex Medical Systems). Subjects were seated with the chair tilted back, the knee flexed, and the ankle in a neutral position. Subjects then pushed against the dynamometer three times for five-seconds, alternating between plantarflexion and dorsiflexion. Plantarflexion strength (PFS) and dorsiflexion strength (DFS) measurements were averaged for each subject, and each subject’s strength was normalized to their body mass.

An independent samples t-test was used to examine strength differences between rearfoot and midfoot/forefoot strikers, while a Pearson correlation analysis was used to assess the relationship between FSI and both PFS and DFS.

RESULTS AND DISCUSSION
24 limbs demonstrated RFS while 26 limbs displayed MFS/FFS. No differences in PFS (p = .42) or DFS (p = .56) were seen between groups. No significant correlations were found between FSI and PFS (p = .24) or between FSI and DFS (p = .70). Data from the study indicates no significant relationships between ankle muscle strength and foot strike patterns (Figure 1).

The data presented is limited by a relatively small sample size. It is also unclear if maximal muscle strength testing is applicable to performance in endurance-type exercise. Similarly, eccentric muscle strength may be more applicable to running [4], compared to the isometric strength testing protocol used in the present study.

CONCLUSIONS
Foot strike position does not seem to affect plantarflexion or dorsiflexion strength, despite previous demonstrations of variations in EMG activity [2]. Future research should examine the influence of knee and hip strength on foot strike patterns.

REFERENCES