

IS MIDFOOT STRIKING DURING RUNNING ADVANTAGEOUS OVER REARFOOT OR FOREFOOT STRIKING?

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INTRODUCTION

The majority of runners strike the ground with their heel first, indicating that they are rearfoot strikers (RFS). However, 25% of runners either land with a midfoot strike (MFS), making contact with a flat foot, or with a forefoot strike (FFS), striking the ground with the ball of their foot [1]. It has been shown that RFS display characteristics of the heel strike transient in their vertical ground reaction forces (GRF) [2]. This causes distinct impact peaks (IP), which can be associated with relatively high instantaneous and average vertical loading rates (IVLR and AVLRL, respectively), and peak positive tibial acceleration (PPA). When increased, this can place the runner at risk for tibial stress fractures [3]. While a FFS pattern reduces these loading variables, it increases the demand on the plantarflexion musculature [2]. This makes these runners more susceptible to Achilles tendinitis. In addition, the ground contact force is concentrated under the ball of the foot, increasing the risk for metatarsalgia.

It is possible that running with a MFS pattern provides a compromise between these two extremes, and may reduce the risk of these injuries. Barefoot runners adapt a MFS pattern in order to reduce the impact loading [4]. These runners anecdotally report fewer injuries since going barefoot [5]. However, studies of MFS running are missing from the literature.

Therefore, the purpose of this study was to compare MFS to RFS and FFS running mechanics. We hypothesized that loading variables, IVLR, AVLRL, IP and PPA MFS will fall between those of RFS and FFS in a group of natural RFS.

METHODS

This is an ongoing study of which five healthy runners have been recruited to date. Subjects were all healthy RFS runners, logging at least 10 miles per week. All rated their treadmill comfort greater than

8/10 on a treadmill comfort scale. A tri-axial accelerometer (PCB Piezotronics, DePew, NY) was tightly affixed to the distal tibia with tape and overwrap. Subjects ran on an instrumented treadmill (AMTI, Watertown, MA). They began their warm-up by walking on the treadmill for 2 minutes. Subjects were then asked to choose a speed they felt they could easily maintain running for 15 minutes. They ran for 5 minutes with their natural RFS pattern, followed by 5 minutes with a MFS pattern and finally 5 minutes with a FFS pattern. They were provided a 1-minute walk period in between each condition. Based on preliminary studies, 5 minutes seemed to be adequate time for subjects to adopt the new strike pattern comfortably. Five consecutive strides for each condition were recorded at the end of each 5-minute period. Ground reaction force and tibial accelerometer data were collected at 1000 Hz, using Nexus (VICON, Oxford, England). Custom code (LabVIEW, National Instruments, Austin, TX) was used to extract AVLRL, IVLR, IP, and PPA the data. AVLRL was the average vertical load rate determined as the slope between points at 20% and 30% of the curve from footstrike to IP. IVLR was the derivative of the vertical GRF just prior to IP. If no IP was present, as is common for FFS, the IVLR was taken at 13% of stance [6]. IP, was the first peak in the vertical GRF, again, if not present, the value at 13% was extracted. Finally, PPA was the maximum peak positive tibial acceleration along the long axis of the tibia.

Due to the currently low subject numbers, data will be compared qualitatively. A difference of 10% was considered meaningful.

RESULTS AND DISCUSSION

Three male and 2 female subjects have completed the study to date. On average, they were 26.8 (4.8) years old, weighed 75.8 (22.3) kg, and were 1.78 (0.17) m tall. All subjects rated their treadmill comfort at 10/10. Self-selected speeds ranged from 2.4-3.3 m/s.

The mean vertical GRF curves for each strike pattern are seen in Figure 1. Note that the patterns are similar between the RFS and MFS patterns. As expected, the FFS pattern was missing a distinct impact peak.

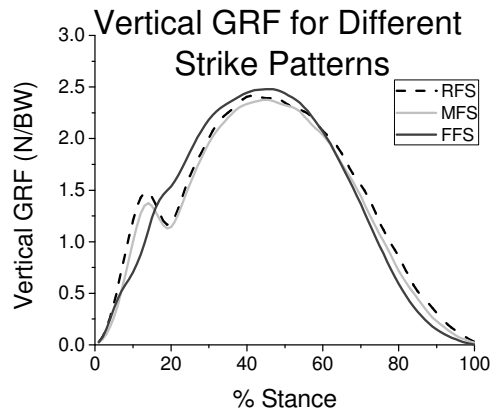


Figure 1. Vertical GRF for rearfoot, midfoot, and forefoot strike patterns. Note the progressively decreased impact peak between the rearfoot, midfoot and forefoot strike patterns.

When analyzing the group mean data for each of the variables of interest, again the MFS values were similar to the RFS values, but different than the FFS values (Figure 2). In all cases, the FFS pattern is associated with lower impact loading.

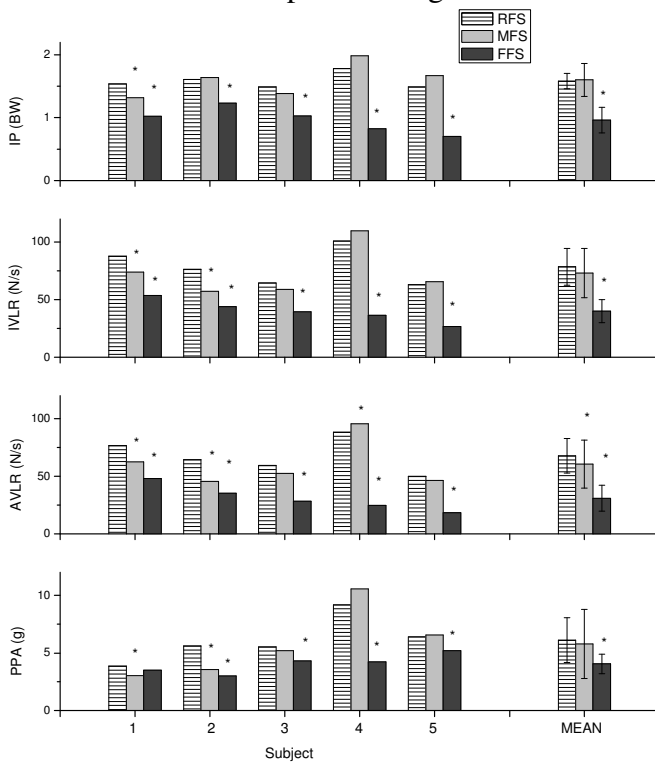


Figure 2. Individual and mean data for the discrete variables of interest. *Indicates >10% difference.

However, a closer look at the individual data reveals some interesting findings about the MFS pattern. Subjects 1-3 demonstrate the expected pattern of

forces, with the highest associated with the RFS, the lowest with the FFS, and the MFS falling in between.

The findings for PPA were less consistent. PPA has been shown to be strongly correlated to vertical loading rates [7]. However, PPA values can be influenced by error associated with accelerometer placement, including location, orientation and tension of the overwrap. This error is not present in the force data. To improve consistency in placement, a single investigator attached the accelerometer for all subjects. However, this likely does not remove all of the error associated with this measure

Subject 4 and 5 demonstrated an increase in most of their impact loads with a MFS pattern. It is possible that these subjects were not comfortable running with the MFS pattern. Both MFS and FFS running was novel to these subjects, however, MFS was the more difficult one to use. In addition, while subjects were asked to run with a flat footstrike, most tended to land with their toes slightly up. This may explain why the MFS was more like the RFS than the FFS. Unfortunately, center of pressure data are not available to calculate the precise strike index associated with the MFS pattern.

This information might be useful in counseling runners with injuries about footstrike patterns. A modification from a RFS to a FFS results in a marked change of kinematics and kinetics [2]. On the other hand, changing from a RFS to a MFS appears to produce more subtle differences. These small changes over many footstrikes, may be enough to reduce a runner's risk for a repeated injury.

CONCLUSIONS

Based upon these very preliminary results, it appears that MFS running is more similar to the RFS pattern than the FFS pattern. However, a MFS pattern appears to be associated with a reduction in impact loading from the RFS pattern.

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