Muscle Activation in Barefoot Running

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ABSTRACT

Background: Those who run in minimalist footwear typically utilize different running mechanics. When running, these individuals initial contact is made in the mid or forefoot. This opposes the modern athletic shoe with built in cushioning which promotes a heel strike for initial contact. Each type of footwear imposes different stresses on the body.

Purpose: The purpose of this study was to compare muscle activation in the lower leg while wearing normal athletic shoes and Vibram Fivefinger toe shoes.

Methods: Three men and 3 women from the UTA student body and from off campus volunteered to participate in this study. Each subject had their body composition measured. Subjects had surface EMG electrodes placed on the tibialis anterior (Ta), peroneus longus (Pl), soleus (So), and gastrocnemius (Ga). Then in a counterbalanced order, each subject completed 10 running trials requiring them to land with their right foot on a force plate for 2 conditions: one with athletic shoes, and one with Vibram Fivefinger toe shoes. Muscle preactvation, reflex activation, speed and change in velocity were recorded during the trials. Dependent t-tests were run using SPSS.

Results: A paired samples test and dependent t-tests revealed the average and significance of preactivation and reflex reaction between finger shoes and athletic shoes.

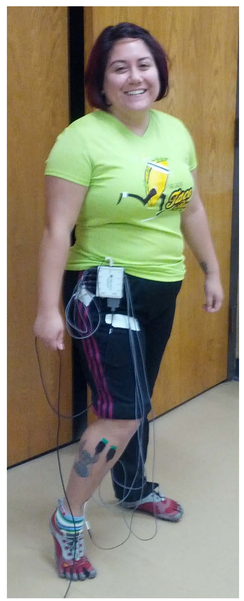
Conclusion: The results of this study indicate that there could be significant differences in muscle activation between the use of athletic shoes and Vibram Fivefinger toe shoes. Future studies need to be performed to examine these differences further.

PURPOSE

The purpose of this study was to compare muscle activation in the lower leg while wearing normal athletic shoes and Vibram Fivefinger toe shoes.

INTRODUCTION

Barefoot or minimalist running is gaining popularity amongst active individuals. This minimalist style of running involves using the body as a kinetic chain to cushion the impact forces of running with initial impact occurring in the middle/front of the foot. By comparison, modern athletic footwear has been developed to have cushioning built into the foot bed, typically with more cushion in the heel, tapering to less cushion towards the toes. This design encourages a heel strike running pattern with the leg in a more ridged or locked position. Electromyography (EMG) is an instrument that allows one to measure the electric signal the muscle emits. Stronger EMG signals indicate more muscle activation. While research has been performed on the force-time curve while running barefoot or in minimalist footwear compared to modern athletic shoed running, little research exists comparing the muscle activation in both Vibram Fivefinger shoes (minimalist footwear) and athletic shoes. It is hypothesized that higher muscle activation levels will exist while wearing the Vibram Fivefinger shoes.



METHODS

Subject Demographics: 3 male and 3 felame, all owners of and experienced running in Vibram Fivefinger shoes and athletic shoes.

	Mean	SD	Max	Min
Height (m)	1.69	±.14	1.83	1.52
Weight (kg)	78.17	± 12.31	95.25	58.97
Body Fat (%)	25.51	±10.68	38.46	12.43
Age (yrs)	24.83	±2.79	28	21

Four surface electrodes were placed on the subject's right lower leg on the tibialis anterior, peroneus longus,, soleus and gastrocnemius. Prior to taping the surface electrodes on the subjects lower leg the electrode locations were prepped by shaving hair with a safety razor and cleaning the area with rubbing alcohol and a gauze pad. The subject then stood still on a force plate to allow for proper calibration. Subjects were then asked to practice running so that their right foot landed on the force plate using their normal running speed. Subjects then ran ten trials, each of which consisted of running for twenty feet, landing on the force plate, and decelerating for 20 feet. Trials were recorded using EMG and a force plate for each of the following conditions: (1) Vibram Fivefinger shoes, (2) running shoes. If the right foot did not land on the force plate or the change in velocity was too great, the trial was discarded and another running trial was recorded. After the subject completed ten running trials for each of the two shoe conditions the surface electrodes were removed and the subject's role in the study was completed. The force recordings of the running motion were then used to compute muscle activation in both of the shoe conditions. The EMG and the force plate data were analyzed by specially written C#.Net computer software to mathematically model the human motion and the changes in muscle activation between the barefoot and running shoe condition. The primary variables that were used to quantify muscle activation in the two shoe conditions were the onset, duration and level of activation of each muscle. The force plate was used to relate the muscle activation to the kinematics and kinetics of running in each shoe condition.
Paired sample analysis and dependent t-tests were performed using SPSS.

RESULTS

EMG Preactivation t-test Results:
Tibialis Anterior Preactivation t(5) = 1.93, p = 0.11*
Peroneus Longus Preactivation, t(5) = .61, p = 0.57
Soleus Preactivation, t(5) = 1.67, p = 0.16*
Gastrocnemius Preactivation, t(5) = 3.42, p = 0.019**
EMG Reflex Amplitude t-test Results
Tibialis Anterior Reflex, t(5) = 0.30, p = 0.78
Peroneus Longus Reflex, t(5) = .09, p = 0.94
Soleus Reflex, t(5) = 2.04, p = 0.097*
Gastrocnemius Reflex, t(5) = 1.17, p = 0.30
Running Speed t(5) = 1.2, p = .28
Change in Anterior-Posterior Velocity, t(5) = 1.54, p = 0.18

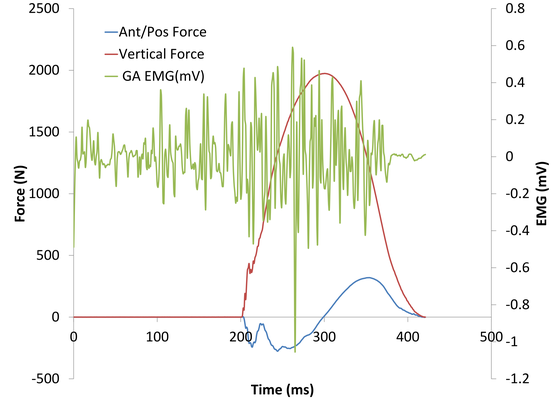


Figure 1: Gastrocnemius Muscle Activation and Contact Forces from Running with Vibram Fivefinger Shoes

CONCLUSIONS

Given the statistical results we fail to accept the null hypothesis that when running in Vibrams there are higher amounts of muscle activation. This could be a result of small sample size as multiple muscles almost exhibited statistical significance. Future studies should be done to gather more information through more subjects, taking EMG readings for additional muscles up the kinetic chain, and utilizing 3D motion tracking of anatomical landmarks with a system like VICON.