EFFECT OF POSITIVE POSTERIOR HEEL FLARE ON KINETICS AND TIBIALIS ANTERIOR MUSCLE ACTIVATION DURING RUNNING GAIT

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INTRODUCTION

Runners can develop exercise induced (EI) anterior compartment syndrome by training in running shoes that are not correct for their foot type, changing from running with a midsole strike pattern to running with a rearfoot strike pattern, running intervals, or running on banked surfaces (Blackman, 2000; Detmer, et al, 1985). The focus of this study was to determine the effect of a positive posterior heel flare (PPHF) on tibialis anterior (TA) activation, sagittal plane dorsiflexion (DF) moment requirement, and ground reaction forces (GRF) during running gait. This study was designed to identify one possible cause for the development of EI anterior compartment syndrome. A PPHF is defined as the presence of the midsole material being inclined posteriorly away from the posterior aspect of the shoe.

METHODS

Each subject was tested in two different running shoes: the Asics Gel Cumulus and the Saucony Grid Trigon. These two shoes were chosen because they had similar properties except for the degree of PPHF. The Saucony Grid Trigon had a positive posterior heel flare of $11^\circ \pm 1^\circ$ with a midsole density of $60 \pm 3$ durometer, while the Asics Gel Cumulus had a positive posterior heel flare of $2^\circ \pm 1^\circ$ and a midsole density of $53 \pm 4$ durometer. Recreational athletes were enrolled as subjects if they demonstrated a rearfoot strike pattern based on an observational video gait analysis. Subjects reported no history of lower extremity injuries in the past six months, no history of a fasciotomy, and were not using foot orthotics.

Muscle activation (telemetry EMG) and GRF (Bertec force plate) were recorded at a sampling rate of 1200Hz, while video data were collected at 120Hz. Seven trials were recorded for each shoe with the subjects running at $\pm 5\%$ of their self-selected speed as determined from the average of five practice trials. Three randomly selected trials were used for analysis. These trials were averaged for the following dependent variables: slope of the vertical GRF (vGRF), peak and mean DF moment requirement, DF angular impulse, peak and mean vGRF, peak posterior GRF (pGRF), mean anterior-posterior GRF (apGRF), and mean amplitude TA activation when a DF moment requirement was present. Each dependent variable was tested using a 2x2 mixed model [one between factor (gender) and one within factor (shoe)] repeated measures ANOVA ($\alpha = 0.05$). The between trial Intraclass Correlation Coefficient [ICC (3,3)] was calculated for all subjects for each dependent variable under each shoe condition. Acceptable between trial reliability was identified as an ICC value greater than 0.70.
RESULTS AND DISCUSSION

Forty-three subjects (19 female, 24 male) ranging in age from 18 to 37 participated in the study. Female subjects had an average age of 23.4 ± 4 years, an average mass of 60.4 ± 7.7 kg, and an average height of 1.66 ± 0.05 m. Male subjects had an average age of 23.5 ± 4 years, an average weight of 74.3 ± 8.9 kg, and an average height of 1.78 ± 0.02 m. All ICC (3,3) values were greater than 0.70 for all dependent variables for both shoes, indicating acceptable reliability.

No gender by shoe interaction existed for any dependent variable. Women had significantly greater TA activation than men (p=0.029). No significant difference in TA activation existed between the two shoes, however, an increasing trend in activation was present for the Saucony (p=0.064). No statistically significant differences existed for gender or shoe for mean vGRF, peak and mean DF moment requirement, and DF angular impulse. The slope of the vGRF was significantly greater for the Asics (p=0.001), with no significant difference between genders. The peak pGRF was significantly greater for men than women (p=0.004), and significantly greater in the Asics shoe (p=0.043). Finally, the mean apGRF was significantly greater in the posterior direction for the men (p=0.002), with no difference between the shoes.

The increase in running speed for the men could explain the increase in the peak pGRF as well as the increase in the mean posterior apGRF. An increase in the PPHF for the Saucony caused a significant decrease in the slope of the vGRF, in spite of the greater midsole stiffness for this shoe. Previous research has indicated that shoes with stiffer midsoles may have higher impact loading rates than shoes with less stiff midsoles (McNair, et al, 1994; Nigg, et al, 1987). The decrease in the slope of the vGRF may have resulted from subjects landing in more DF, with greater DF excursion resulting in the vGRF being applied over a longer time, thereby decreasing the slope of the vGRF.

SUMMARY

While no significant difference existed between the shoes for the mean amplitude activation of the TA, the results indicated a trend towards an increase in TA muscle activation for the Saucony. This increase in muscle activation could possibly lead to an increase in pressure within the anterior compartment, potentially leading to the development of EI anterior compartment syndrome. An increase in the amount of ankle motion could possibly explain the attenuation of the GRF and the slope of the vGRF from heel strike to impact peak. Use of this strategy to accommodate to shoes with increased PPHF and increased midsole stiffness may also be linked to increased TA muscle activation.

REFERENCES


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