# THE EFFECT OF MOTION CONTROL AND CUSHIONING SHOES ON HIGH AND LOW ARCHED RUNNERS

Robert J. Butler[1], Irene Davis[1,2], & Joseph Hamill[2]
[1]University of Delaware, [2]Drayer Physical Therapy Institute& [3] University of Massachusetts at Amherst

## INTRODUCTION

Running injuries are thought to be caused by excessive motion or impact shock during stance. Running shoes are designed to control foot motion and attenuate impact shock. These types of shoes may be even more important for high and low arched individuals who have been reported to have a greater incidence of overuse injuries compared to individuals with average arch structure (Kaufman et al., 1999). It has recently been reported that running shoe recommendations, based on foot type, can reduce the incidence of overuse injuries (Knapik, 1999). However, how footwear interacts with arch type in runners, particularly during a prolonged run when most overuse injuries are thought to occur is not well documented.

Fatigue associated with a prolonged run has been shown to be related to voluntary strength decrements (Gleeson, 1998; Lepers, 2000; Nicol, 1991). These strength decrements likely lead to kinematic and kinetic changes. Derrick et al (2001) reported an increase in rearfoot motion along with an increase in tibial shock over the course of a 2 mile maximal effort run. Additionally, Mizrahi (2000) reported an increase in peak tibial shock over the course of a 30 minute run at a pace just below anaerobic threshold. However, none of these changes have been evaluated in high and low arched runners. These runners, who have an increased risk of injuries compared to normal arched runners, may show greater changes in their mechanics during a run due to their increased risk of over use injuries.

Therefore, the purpose of this study was to evaluate changes in kinematics and kinetics when low and high arched runners wear motion control and cushioning shoes over the course of a prolonged run. It was hypothesized that, in low arched runners, rearfoot and tibial motion will not increase in the motion control shoe but will increase in the cushioning shoe over the course of the prolonged run. With respect to high arched runners, it was hypothesized that tibial shock will not increase in the cushioning shoe, but will increase in the motion control shoe during the prolonged run.

## METHODS

Twelve high arch (HA) and twelve low arch (LA) recreational runners were evaluated for this study. The subjects were classified as being HA or LA by being 1.5 sd above or below their gender specific arch index mean value. The average arch height index value was 0.273 (2.4 sd) for the LA runners and 0.390 (1.8 sd) for the HA runners. The runners visited the lab on two separate days that were at least one day apart to run in each footwear condition. The two running shoes used were the New Balance 1021 (motion control shoe, MC) and the New Balance 1022 (cushioning shoe, CT). The classification of the shoes was deemed by the footwear company.

Retroreflective markers were placed unilaterally on the limb with the most extreme arch height to define joint segments and establish anatomical coordinate systems. A uniaxial accelerometer was placed on the anteromedial aspect of the distal tibia to record tibial shock. The runners were given a 5 minute warm-up jog before beginning the prolonged run at a self selected training pace for a 30-45 minute run. Data were collected 5 min into the run and just before termination of the run. The run was terminated when the subjects exceeded a "hard physical intensity" as defined by the American College of Sports Medicine (>85% age specific heart rate maximum or >16 on a rate of perceived exertion). The termination criteria were monitored every 5 minutes. The variables of interest for the study were peak motion and excursion in rearfoot eversion and tibial rotation along with peak positive tibial acceleration.

The data were analyzed using a two way repeated measures (shoe, time) ANOVA with a criterion alpha level of $p= 0.05$. A different ANOVA was used for each arch type. All of the variables of interest were examined for the HA and LA runners.

## RESULTS AND DISCUSSION

*Low arched runners*

No shoe by time interaction for peak eversion or eversion excursion was observed in the LA runners. For both shoe conditions, eversion remained unchanged over the course of the prolonged run. This is interesting in light of the increase in eversion noted by Derrick et al. (2001). It was also interesting to find that the MC shoe did not provide any additional control compared to the CT shoe.

A significant shoe by time interaction was noted for peak tibial internal rotation (Fig.1). The motion control shoe decreased the amount of tibial internal rotation while wearing the cushioning shoe resulted in an increase in tibial internal rotation over the course of the prolonged run. It is possible that the shoe provides more control of the midfoot than the rearfoot. Control of the talonavicular joint may have influenced tibial motion and not calcaneal. This might explain the lack of findings in the rearfoot. A reduction in the peak tibial rotation may reduce the strain on the patellofemoral joint and potentially reduce the incidence of knee injuries that is more common in LA runners (Williams et al., 2001).

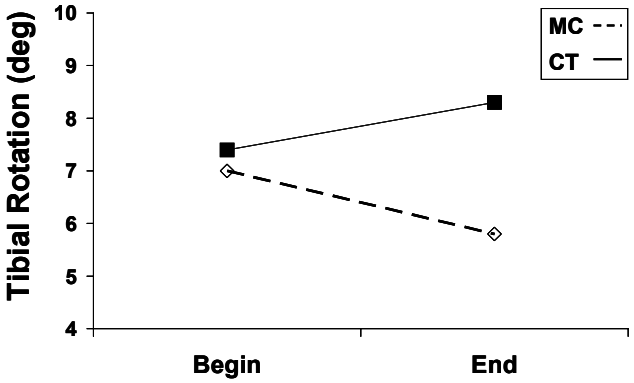


**Figure 1. The effect of motion control (MC) and cushioning (CT) shoes on peak tibial rotation in low arched runners during a prolonged run**

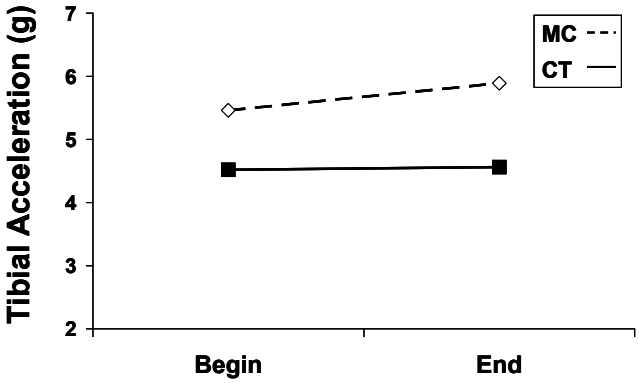


**Figure 2. The effect of motion control (MC) and cushioning (CT) shoes on peak tibial acceleration in high arched runners during a prolonged run**

*High arched runners*

No shoe by time interaction was observed for tibial shock. Both shoes resulted in a constant tibial shock over the course of the run. However, there was a main effect for shoe with wearing the CT resulting in less tibial shock than wearing the MC. This reduction in tibial shock assists in potentially reducing injuries ion high arched runners due to their higher risk of sustaining bony injuries. (Williams et al., 2001).

## CONCLUSION

MC shoes have a greater effect on tibial internal rotation in LA runners compared to a CT shoes. In HA subjects, running in the CT shoes was beneficial during a prolonged run since it reduces tibial shock compared to a MC shoes.

## REFERENCES


Kaufman, K.R., et al. (1999) *Amer J Sports Med* **27**(5): 585-593.

Knapik, J.J, et al. (2001) *U.S. Army Center for Health Prom. and Prev. Medicine*. 12-MA-6558-01.

Gleeson, N.P. et al. (1998) *Med Sci Sport Exer* **30**(4): 596-608.

Lepers, R., et al. (2000) *Int J Sports Med* 21: 275-280.

Nicol, C, et al. (1991) *Scand J Med Sci Sports* **1**: 10-17.

Derrick, T.R., et al. (2001) *Med Sci Sports Exer* **34**(6): 998-1002.

Mizrahi, J., et al. (2000) *Hum Mov Sci* **19**: 139-151.

Williams et al. (2001) *Clin Biomech* **16**: 341-347.