THE EFFECTS OF A RIGID SHANK SHOE ON PLANTAR FASCIITIS IN RUNNERS

Susan E. D’Andrea1, Kasey R. Parker1,3, Jason Novick2, Michael Kahelin1, Patrick McKee2 and Alex Kor2

Departments of 1Biomedical Engineering and 2Orthopaedic Surgery, The Cleveland Clinic Foundation, Cleveland, OH
3School of Human Kinetics, University of Ottawa, Ottawa, Ontario, CANADA

Contact information: dandreas@bme.ri.ccf.org, http://www.lerner.ccf.org/bme/biomechanics/

INTRODUCTION

Plantar fasciitis is a common inflammation of the broad-based ligament extending from the calcaneus to a point just proximal to the metatarsal heads (Hlavac, 2001). In high impact, repetitive sports such as running, 10% of all injuries can be attributed to this condition (Tauton et al, 2002). Although medical experts do not entirely agree on the specific cause, most practitioners and investigators include the following etiologies: shape and structure of the foot, activity level of the patient, weight of the patient, the playing surface and the quality of the shoe gear (Thomas et al, 2001; Wilke, Fischer and Gutierrez, 2001).

The current study focuses on the concept that an increase in the rigidity of the shank region of running shoes will decrease the overload on the plantar fascia and thus alleviate the symptoms of plantar fasciitis. To date, shoe stiffness and dynamic deformation have been assessed through computerized gait analyses, ground reaction forces and mechanical three-point bending tests.

METHODS

Running shoes from the stability, motion control and cushioned categories were evaluated and selected by an experienced podiatrist. Each pair was obtained unused from a local running shoe store. Selections for the study were based on the flexibility of the shank of the shoe. Two flexible shoes and two rigid shoes were assigned to the stability and motion control categories. Two flexible and one rigid shoe were assigned to the cushioned shoe group.

Three point bending tests were performed on all shoes (Figure 1, MTS, Minneapolis, MN). Load was applied through displacement control at 5 mm/s to a maximum of 30 mm. This position was maintained for 1 second and then the load was released at 5 mm/s. This cycle was repeated 5 times with a 30 second hold between cycles allowing the material to relax. Force and deformation were recorded for each cycle and stiffness values were calculated in the steepest region of the elastic portion of the each curve.

Figure 1. MTS Testing Apparatus

In order to determine the dynamic range of the shoe shank, motion analysis data was recorded while the subject was running on an instrumented treadmill at 10 km/hr. Eight retro-reflective markers were place on the tibia and shoe (Figure 2).

Figure 2: Marker Placement

Subjects were grouped according to foot type–cavus, pes planus or neutral. Two subjects were selected for each group and fitted with the
appropriate shoes – cushioned, motion control and stability, respectively. Each subject tested three or four pairs of shoes.

Marker position and ground reaction force data were collected for ten seconds. The rear foot angle and the shoe shank angle, as defined by the apex of the triangle on the shank of the shoe, were calculated and a custom LabVIEW (National Instruments, TX) program segmented and normalized each gait cycle according to the force profile. The maximum range was determined for both the rear foot and shoe shank angles during stance. Angular data were correlated with stiffness values by shoe type.

RESULTS AND DISCUSSION
Since it is widely accepted that the flexibility in a shoe can be a major contributing factor to the onset of plantar fasciitis, a shank-bending threshold was determined based upon stiffness values (Figure 3). The threshold was established based upon group wise comparisons and represents the level of shoe stiffness below which the stretch in the arch during repetitive loading of the foot would be amplified. Only shoes with stiffness values above 27 N/mm were used in subsequent investigations.

Correlations between these variables for other shoe types were not as straight forward and further analysis is necessary to determine peripheral factors.

Figure 3: Average Stiffness by Shoe Type. C: cushion type shoe; M: motion control type shoe; S: stability type shoe

Calculated rear foot and shoe shank angles were consistent within and between subjects and corresponded with values found in the literature (Areblad et al, 1990; Figure 4).

The dynamic range of the shoe was evaluated by the change of the shoe shank angle during running. The relationship between the angle range and the shoe stiffness was strongest in the cushion-type shoes ($R^2 > 0.88$, Figure 5).

Figure 4: Representative rear foot (a) and midfoot (b) angles during the stance phase of running.

Figure 5: Relationship between three-point bending shoe stiffness and shoe shank motion.

SUMMARY
Currently, longitudinal studies are being completed to evaluate thirty runners with plantar fasciitis after being given a stiffer shoe as indicated by the present analysis. Data will help to ascertain the effectiveness of a rigid shoe shank on the outcome and recovery of this condition.

REFERENCES

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