Journal of Foot and Ankle Research

BioMed Central

Oral presentation

Open Access

Effects of different shoe lacing patterns on perceptual variables and dorsal pressure distribution in heel-toe running

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from 1st Congress of the International Foot & Ankle Biomechanics (i-FAB) community
Bologna, Italy. 4–6 September 2008

Published: 26 September 2008

Journal of Foot and Ankle Research 2008, **1**(Suppl 1):O13 doi:10.1186/1757-1146-1-S1-O13

This abstract is available from: http://www.jfootankleres.com/content/1/S1/O13

Introduction

Foot movement in heel-toe running is influenced by various shoe lacing patterns [1]. Different shoe lacing systems and techniques also offer the possibility to improve shoe fit and shoe comfort. The purpose of this study was to investigate the effects of different lacing patterns on dorsal foot pressures during running. Furthermore, perceived comfort and shoe stability ratings were recorded.

Methods

14 experienced male rearfoot runners ran with the same running shoe (Nike Air Pegasus) in 6 different lacing conditions (randomized order) across a Kistler force platform at a speed of 3.3 m/s. Using pedar insoles (Novel) plantar and dorsal pressure distributions were measured. The dorsal sole was attached to the inside of the shoe's tongue. The 54 active sensors on the foot dorsum were divided into 8 masks. The anatomical locations of the pressure sensors were identified by MRT-scans. One typical subject, wearing the test shoe and a modified sole with MRT-markers was scanned. The markers were placed on the sole at identical locations of the 54 sensors. Figure 1.

The lacing conditions differed in the number of laced eyelets and individually chosen lacing tightness (weak – NL1; regular – NM2; tight – NF3). Subjectively perceived comfort and stability within the shoe were identified on a perception scale. Shoe lacing comparisons were carried out using one-way repeated measures ANOVA with post hoc t-tests ($p < 0.05$). Average perceptual ratings were related to peak dorsal pressures with correlation and regression analyses.

Results

The subjects perceived the tightest six-eyelet lacing NF3 and the seven-eyelet lacings (A57, ALL) as the most stable conditions. The most comfortable lacing was A57, followed by the regular 6-eyelet lacing (NM2). Lacing ALL was perceived slightly less comfortable than NM2. The highest peak dorsal pressures were localized on the medial side of the foot dorsum: the talus and navicular, the medial cuneiform bone, and first metatarsal head. In the lower (135) and weaker (NL1) lacings peak dorsal pressures were significantly reduced on the tarsal bones

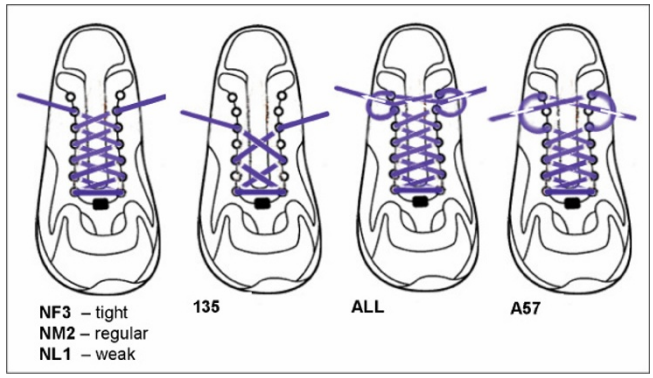

Figure 1
Lacing conditions.

and the extensor tendons compared to most other conditions. Compared to ALL, leaving out the sixth eyelet in A57, resulted in significantly lower ($p < 0.05$) peak dorsal pressures on the talus and navicular bone and lower peak pressures on the extensor tendons. Peak plantar heel pressures were significantly ($p < 0.05$) reduced in ALL and A57.

The correlation analyses revealed a highly significant ($p < 0.01$) relationship between perceived stability and peak dorsal pressures on the talus and navicular bone ($r^2 = 0.89$) and the extensor tendons ($r^2 = 0.97$). No significant relationship was found between perceived comfort and dorsal pressure data.

Conclusion

The perception analyses indicate that a certain amount of lacing tightness is necessary to feel comfortable in the running shoe. Both 7-eyelet lacing techniques enhance perceived stability and can be recommended as very well foot-to-shoe-coupling techniques – with highest comfort in A57. The knowledge of the location of the peak dorsal pressures is useful for new tongue constructions and lacing systems to improve comfort in running shoes.

References

1. Hagen M, Hennig EM: *J Sports Sci* 2008 in press.