Journal of Foot and Ankle Research

BioMed Central

Oral presentation

Open Access

Heel strike angle and foot angular velocity in the sagittal plane during running in different shoe conditions

Jens Heidenfelder*, Thorsten Sterzing, Manuel Bullmann and Thomas L Milani

Address: Department of Human Locomotion, Chemnitz University of Technology, Chemnitz, Germany

Email: Jens Heidenfelder* - jens.heidenfelder@phil.tu-chemnitz.de

* Corresponding author

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):O16 doi:10.1186/1757-1146-1-S1-O16

This abstract is available from: http://www.jfootankleres.com/content/1/S1/O16

Introduction

Runners change their running style, e.g. heel strike strategy, to adapt to different shoe conditions [1]. Various mechanisms for adaptation are discussed [2,3]. Alteration of stiffness of the ankle joint at heel strike by dorsiflexion or plantarflexion of the foot seems to be disregarded as mechanism of adaptation.

In this study, alterations of heel strike angle (HSA) and plantarflexion velocity (PFV) in the sagittal plane due to wearing different shoe conditions was examined. By this, adaptation in running style as a mechanism of shock attenuation should be investigated.

Methods

Twenty-four male, injury-free recreational runners (age: 24.8 ± 2.5 years, height: 177.7 ± 5.8 cm, weight: 73.1 ± 7.1 kg) participated in this study. Three running shoes differing in heel height and cushioning properties were used: S1 = low heel, less cushioning; S2 = low heel, medium cushioning; S3 = high heel, medium cushioning.

Subjects performed five repetitive running trials across a force plate (Kistler 9287BA) at a speed of 3.5 ± 0.1 m/s. Kinetic parameters like peak vertical impact force (PVF1) and corresponding force rising rate (FRR) were obtained at a sampling rate of 1 kHz. Kinematic data of the foot and the shank were collected using a nine camera motion cap-

shoe	HSA [°]	PFV [°/s]	PVF1 [BW]	FRR [BW/s]
S1	26.7 (4.1)	484 (54)	1.92 (0.22)	84.5 (13.9)
S2	28.1 (3.6)	513 (59)	1.76 (0.23)	63.5 (10.8)
S3	28.7 (3.8)	488 (50)	1.73 (0.26)	58.3 (7.7)
p	<.01	<.01	<.01	<.01

Figure 1
Means (SD) of kinematic and kinetic parameters for the three shoe conditions.

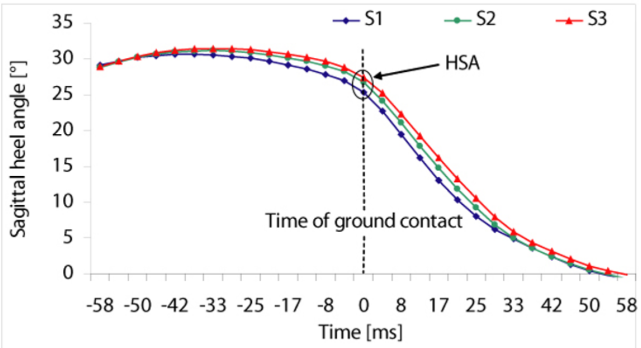

Figure 2
Progression of heel angle.

ture system (Vicon MX 3) at a sampling rate of 240 Hz. HSA in the sagittal plane and average corresponding PFV during touch down were calculated. A one-way repeated measures ANOVA was performed for each parameter in order to compare effects of the three shoe conditions. Furthermore, intraindividual variability across all subjects and shoes was quantified by the coefficient of variation ($COV_{Ø}$).

Results

For kinematic and kinetic parameters highly significant differences were found between shoe conditions (Figure 1). Comparing progression of heel angle around touchdown ± 30 ms increased cushioning conditions (S2, S3) resulted in higher HSA (Figure 2).

HSA and PFV show an individual range from 15.3° to 36.1° and 377°/s to 664°/s between subjects and shoes. Low intraindividual variability of subjects was found for all shoe conditions ($COV_{ØHSA}$ = 5.4%, $COV_{ØPFV}$ = 5.6%).

No correlation was observed between HSA, PFV, and the kinetic impact parameters for individual subjects.

Conclusion

Significant differences of HSA and PFV between shoes support the assumption that heel strike angle and plantarflexion velocity in the sagittal plane are used to adapt to different shoe conditions independent from impact parameters. Furthermore, due to small intraindividual variability, it seems that magnitude of HSA and PFV is a characteristic feature of individual running style.

Acknowledgements

This research was supported by Puma Inc., Germany.

References

1. Nigg BM: *Human Kinetics, Champaign, IL*; 1986.
2. Frederick EC: *J Sports Science* 1986, **4**:169-184.
3. Mercer JA, *et al.*: *Eur J Appl Physiol* 2002, **87**:403-408.