Influence of functional foot orthoses on the plantar pressure of 5 handball athletes – analysis using a novel system during 3 athletic tasks

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Abstract

In Sports involving high impact forces, like handball, the intense effort alongside the set of repetitive motions are connected with an increase on forefoot plantar pressure consequently increasing injury probability. As a preventive measure, use of functional foot orthoses (FFO) is recommended for plantar pressure redistribution.
The goal of this study was to determine functional foot orthoses influence on forefoot plantar pressure, during 3 athletic movements. Two tests were performed in 5 athletes, one with standard insole and the other with a functional foot.

Introduction

Handball is a high intensity sport related to high levels of fatigue and it combines several elements from basketball, football and hockey[1,2]. Complexity of movements often expose players to an increased load in the ankle joints and calcaneus leading to injuries[3]. During 2004 and 2008 Olympic games, number of injuries was higher in handball and football[4]. Most injuries occur during competition[5,6] affecting mostly the lower limb (42%) with some studies pointing the excessive plantar pressure as one of the main causes to injury in the lower limb[7,8].

FFOs have been associated with improvement in comfort, pain relief, and peak pressure decrease[9,10]. However, scientific literature concerning plantar pressure in specific sports-related movements is limited.

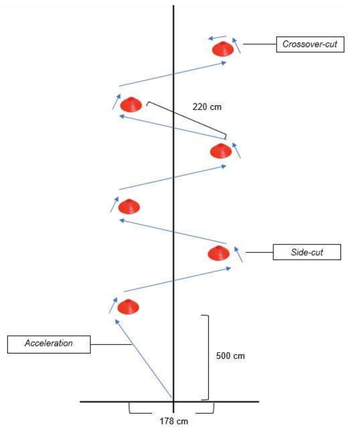

Figure 1. Experimental course (Queen et al., 2007) [11]

Methods and Materials

Type of study*: Multiple-case studies observational with convenience sampling.

Participants: 5 male handball players of the 2nd national league team CDE Camões (Table 1).

- **Exclusion criteria:** previous muscle or ligament injuries, use of functional foot orthoses, pathology in the lower limbs or past surgeries in the knee or ankle.
- **Inclusion criteria**:** handball players, age > 22 years; > 6h physical activity; 42-44.5 shoe size.

Instruments

Smart insole with 8 pressure sensors composed by one foot-pod, multiaxial accelerometer, gyroscope, Bluetooth and GPS. The foot-pod with a 7 hour battery sampled with 200Hz frequency. Calibration by statically loading known weights was performed resulting in a sensor output range of 6-731kPa.

Experimental procedure

Two tests were carried out with the measurement system and athletes own footwear.

- **Control:** course with normal shoe insole;
- **Experimental:** course with functional foot orthoses.

The course (Fig. 1) was performed at maximum speed, consisting of three main tasks[11]:

- **Forward acceleration**;
- **Side-cut** - direction change to the left, with the right foot in support;
- **Crossover-cut** – direction change to the left, with the left foot in support, and with the right foot crossing previously to the left foot.

	Sample (N=5)	
	Mean	*SD*
Age (years)	26.8	2.16
Weight (kg)	74.8	14.6
Height (cm)	178.2	4.3
Shoe size (EU)	42.8	1.51
Physical activity (h/week)	10.8	3.3

Table 1. Sample data

Results

Acceleration (Fig. 2): Pressure decrease was demonstrated on all forefoot regions, with the exception of the lesser toes and lateral forefoot, while using functional foot orthoses (experimental). Major reduction was observed on the hallux (24%).

Side cut (Fig. 3): Functional foot orthoses use resulted in pressure reduction for every forefoot region except for lesser toes (22% increase). In the experimental condition the lateral and medial forefoot were followed by pressure decreases of 36% and 11%, respectively. Statistically significant decreases were found with p = 0.022 and p = 0.029, respectively.

Crossover cut (Fig. 4): Pressure reductions were observed across each foot region, with the higher decrease occurring on the medial forefoot (23%) and the lower on the lesser toes (14%) and lateral forefoot (14%).

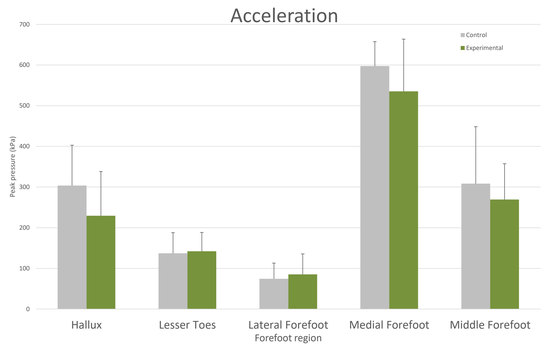

Figure 2. Peak pressure during the acceleration task, kPa.

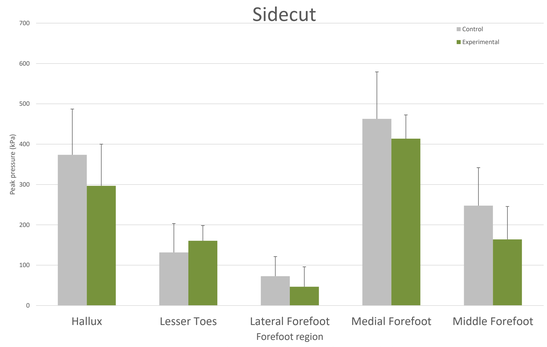

Figure 3. Peak pressure during side cut task, kPa.

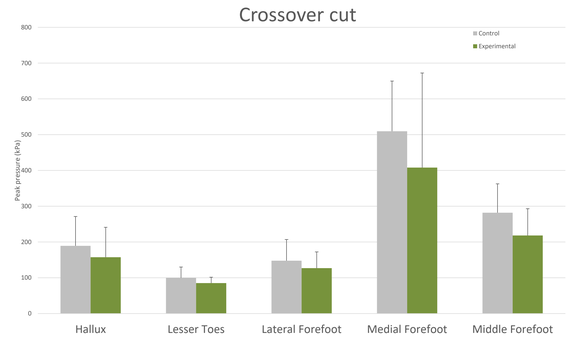

Figure 4. Peak pressure during crossover cut task, kPa.

Discussion

During acceleration task hallux and lesser toes demonstrated higher peak pressure values, in comparison with the remaining tasks. For the side cut task, use of functional foot orthoses reduced peak pressure in every forefoot area exception for lesser toes. During crossover cut, FFOs reduced pressure for all five foot region.

Reduced peak pressures might be linked to the arch-supported mechanism of the FFOs, which suggests that load from the forefoot and rear foot can be shifted to the mid foot thus reducing forefoot and rear foot pressure[12,13].

Another positive analysis of our results are the statistically significant decreases for one specific subject, with low medial arch foot and higher peak pressure values on the medial forefoot and hallux with the normal insole (also, higher sample values). The same individual registered significant pressure decrease when using functional foot orthoses.

Conclusions

Results indicated that the functional foot orthoses reduced plantar pressure. Meanwhile, only for hallux and the middle forefoot regions were found statistically significant reductions, when performing side cut task.

Further investigation is needed in order to verify the significance of functional foot orthoses use in sports. Sample size increase of our study is a potential improvement in the future as well as reproducibility of course tests to meliorate the understanding of specific-related sports tasks.

Acknowledgments

We thank the companies involved in this project: Vilsad Lda, for the contribution of the necessary material for anamnesis; "Ortopedia Moderna" for authorizing the use of orthopedic facilities, needed for manufacture of the plantar orthoses included in this work. To "Clube Desportivo Escolar Camoes" and its athletes for participating in this study. To Escola Superior de Tecnologia da Saúde de Lisboa and Joao Costa, PhD, professor at Instituto Superior de Engenharia de Lisboa, for his assistance with sensors.

Finally, a special acknowledgement to our friends and family who helped us along this study, among them: João Afonso, Msc Chemical Engineering at Instituto Superior Técnico; Martin Jusek, std of Chemical Engineering at Instituto Superior Técnico; and Mário Morgado, std of Mechanical Engineering at Faculdade de Engenharia da Universidade do Porto.

*Respective ethics council of Escola Superior de Tecnologia da Saúde de Lisboa was required for approval regarding ethical sampling considerations.
**Written informed consent forms were obtained from all the participants.

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