SOCCER SHOES REDUCE FOOT SENSITIVITY COMPARED TO BAREFOOT FOR EXTERNAL VIBRATION STIMULI

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INTRODUCTION

The human foot as a sensory organ uses tactile stimuli from its environment to adapt motor performance. Touch pressure and vibration stimuli are recognized by Merkel, Meissner, and Pacini skin mechanoreceptors. A sensitivity mapping for touch pressure and vibration stimuli showed different sensitivity levels of the numerous anatomical locations of the foot (Sterzing et al., 2006). Regarding motor performance, plantar foot sensitivity supports balance tasks (Perry et al., 2000). Foot sensitivity is likely to be decreased in athletes performing shod sports compared to athletes performing unshod sports (Schlee et al., 2007). This indicates the necessity to consider the role of footwear with respect to foot sensitivity in sports performance.
For soccer players ball sensing is an important shoe property (Sterzing et al., 2007). Soccer shoes act as artificial interfaces between the foot and the ball. They need to protect the player's foot but should also allow optimal ball handling, thereby supporting technical skills of the players. Sensory information is a crucial input variable for ball handling. Thus, the purpose of this study was to examine vibration sensitivity of the foot in different soccer shoe models compared to barefoot.

METHODS AND PROCEDURES

15 experienced soccer players took part in the study (game experience: 15,0±3,9 years; age: 23,8±2,7 years; height: 175,5±3,9 cm; weight: 70,9±6,1 kg). Four shoe conditions and the barefoot condition were included in the test: Puma King (PKT), Puma V-Konstrukt (PVK), Puma V1 (PV1), Nike Mercurial Vapor (NMV), and Barefoot (BAR). Whereas PKT (3,8mm) and PVK (3,9mm) have rather thick shoe upper materials and a relatively wide forefoot fit, PV1 (1,4mm) and NMV (2,2mm) have rather thin shoe upper materials and a relatively narrow forefoot fit (Figure 1).

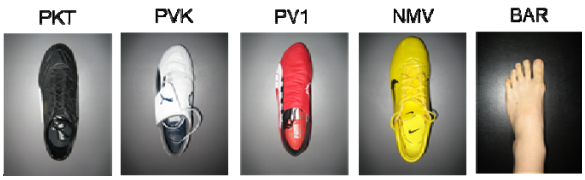

Figure 1: Foot/shoe conditions

Vibration sensitivity was measured at four anatomical locations of the shoe/foot:

- MM-I medial metatarsal head I
- DM-I dorsal metatarsal head I
- DM-V dorsal metatarsal head V
- LM-V lateral metatarsal head V

These locations are important for accurate passing, receiving and handling of the ball. Measurements were performed with a Horwell Neurothesiometer (Scientific Laboratory Supplies Ltd., Nottingham, UK) at a frequency of 100Hz. Vibration amplitude was increased until subjects perceived the stimulus. In the shod conditions the anatomical locations were palpated through the shoe and marked for each subject individually prior to the testing. Five repetitive trials were performed per anatomical location and foot/shoe condition. For statistical analysis mean values of the three most homogenous trials (CoV) were calculated. A repeated measures ANOVA and

Post-Hoc tests according to Fishers' PLSD were performed to identify differences between the foot/shoe conditions and between anatomical locations.

RESULTS

Mean barefoot vibration sensitivity of the four anatomical locations of the foot is lower than mean shod sensitivity of all tested shoe conditions ($p<0,01$). Among the shoe conditions there were no statistically different vibration thresholds (Figure 2). Lower vibration thresholds of barefoot compared to shod conditions are present for all examined anatomical locations ($p<0,01$).

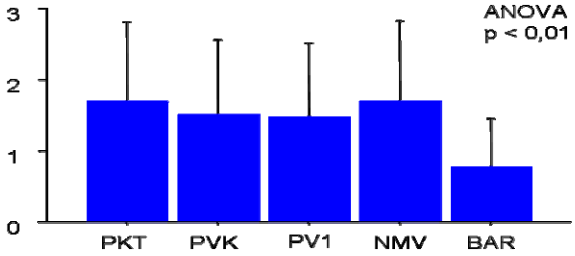

Figure 2: Shoe/foot vibration thresholds [µm]

The medial metatarsal head I is the least sensitive anatomical location whereas the lateral metatarsal head V is the most sensitive anatomical location when wearing soccer shoes ($p<0,01$). Shoe means are presented in Figure 3.

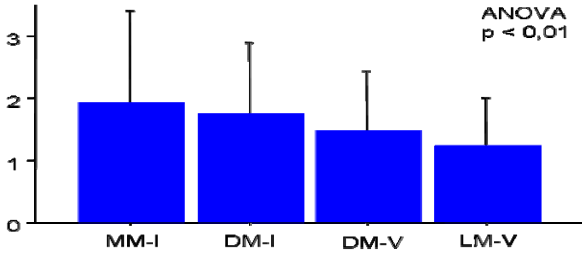

Figure 3: Shod vibration thresholds of anatomical locations [µm]

DISCUSSION

The transfer quality of external vibration stimuli to the foot via artificial interfaces like soccer shoes is likely to be dependent on the type and thickness of the shoe upper material. Also, an anatomically rather tight or wide fit of the shoe may have an effect. In this study these factors potentially cancel out with respect to shoe discrimination. To solidly investigate these ideas, a systematically designed variety of shoes needs to be built in order to isolatedly examine the addressed aspects. Vibration sensitivity at the metatarsal head I is lower than at the metatarsal head V when wearing soccer shoes. As most ball handling actions are performed with the inside and the inner instep of the shoe/foot this creates a margin for shoe improvement.

SUMMARY

Soccer shoes reduce vibration sensitivity with respect to external stimuli compared to barefoot. Differences between soccer shoes with regard to transfer quality of external vibration stimuli to the foot were not found. In this study this might be due to the relatively low number of subjects with respect to natural high variability of sensitivity measurements and negative interaction of shoe properties. In general, the influence of foot sensitivity level on ball handling skills of players is not yet determined and thus needs to be investigated.

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