ANALYSIS OF THE HORIZONTAL FORCES IN SOCCER BOOT STUDS FOR SPECIFIC MOVEMENTS

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INTRODUCTION

Studs in soccer boots are the elements responsible of traction. Secure traction is fundamental for rapid acceleration changes of direction and kicking. The goal of this study is to characterize and compare horizontal forces in individual studs during different soccer specific movements. A soccer boot with 13 studs instrumented with strain gauges was employed for measuring forces in each stud. Maximum forces for specific studs as well as their direction were obtained for five common movements in soccer. The results obtained with this study give valuable information for the design of soccer boots studs from a biomechanical point of view.

REVIEW AND THEORY

In the actions performed while playing soccer, one of the most important factors related to performance and injuries is the shoe-surface interface. The studs are the elements responsible for the traction in soccer boots, being fundamental for improvement in performance during movements, and particularly during accelerations (sprints), braking and changes of direction. Studs not only affect performance, but also are frequently related with typical soccer player problems such as ligamentous knee injuries (Chang, 1993; Masson, 1989), and also with fractures from overload of the foot bones due to problems caused by a bad distribution of plantar pressures. In this way, performance and other aspects such as lateral stability of the foot and comfort could be affected by both the number and the distribution of the studs on the sole (Lambson et al., 1996; Torg et al., 1974).

Although in soccer boots each stud has a different function (stabilisation or propulsion) depending on its position (Daum,1990), to date the studies carried out are based on the measurement of reaction forces using force plates (Lees & Kewley, 1993; Morag & Johnson, 2001) or the in-shoe pressures on the foot plant (Eils, 2001). However, there are no studies about individual traction forces on studs, which could provide valuable information for designing studs from a biomechanical point of view. For this, a system based on strain gauge technology capable of measuring forces in each stud has been used (Garcia, 1999).

PROCEDURES

Thirteen studs instrumented with strain gauges were employed to measure the forces in anterior-posterior and medial-lateral direction in every stud in real soccer actions. A standard boot with kangaroo leather, polyurethane sole and metallic studs was used. The signal from the 13 studs (26 channels) passes to the amplifier fixed to the soccer player's leg. From the amplifier the signal is multiplexed and sent to the computer. The signal is acquired by a PCMCIA card without filtering at a sampling frequency of 50Hz.

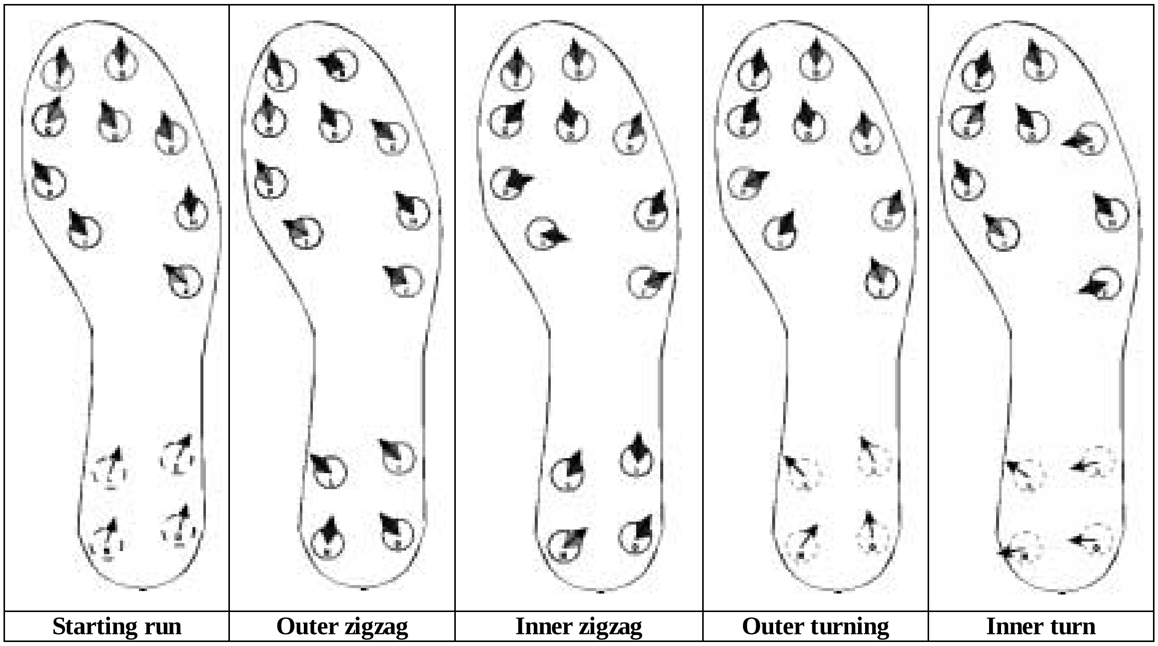
Five males recruited among semi-professional soccer teams participated in the experiment. At the time of the experiment, the subjects were free from injury. They performed five repetitions of five common movements in soccer. These movements were selected because they are frequently related to the most typical injuries suffered by soccer players and because the influence of the studs could be important for the efficiency of the action. These movements were: starting run, inner and outer zigzag and inner and outer turning.

Specific analysis software has been developed in MATLAB to read the acquired signals. The modulus of the maximum peak force, its direction and the instant when this peak occurs, and the time during which the force is actuating were obtained for each stud and action. Analysis of variance for each movement with the alpha-level set to 5% was used for statistical analysis with the subject and stud as factors.

RESULTS and DISCUSSION

Significant statistical differences ($p<0.05$) among studs and subjects were obtained in horizontal forces. For the five movements the peak forces and their direction for each stud were analysed (Figure 1).

The outer forward studs presented the higher forces and time of actuation during the movements studied. The forces in the rear studs were very low in the majority of movements being limited basically to the heel contact in the zigzag movement. Except for the starting, two phases were detected in the other movements - first a braking force followed by a traction effort. The most forward studs (A and B) were the last in applying the loads, indicating that the order was dependent on the movement performed.



High forces Mean forces Low forces Very low forces

Figure 1: Maximum loads and direction of forces in the studs in the different movements.

These results show the existence of differences in the actuation of the studs defined by the magnitude and direction of the loads applied and by the time when these are active. This suggests the existence of different areas of actuation that will require diverse design parameters for studs.

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