

DESIGN CRITERIA FOR SOCCER FOOTWEAR ON EARTH PITCHES

Antonio Martínez, Pedro Pérez, Javier Gámez, Juan Carlos González,
Lirios Dueñas, Roberto Ferrandis.
Institute of Biomechanics of Valencia (IBV)
Valencia. Spain

The footwear used for soccer practise on earth pitches requires different characteristics from the one used on other surfaces. There are no studies focussed on this type of footwear. The study presented has two main objectives; on the one hand knowing the problems related to the footwear used nowadays on earth pitches and on the other hand, generate suitable criteria for this type of footwear. User panels and surveys about epidemiology were carried out; The comfort perceived by footballers with different footwear models was valued, as well as the analysis of the plantar pressures in this footwear using the plantar pressures measuring equipment Biofoot/IBV. The results allowed to identify the most valuable aspects of this footwear; sprain of ankle and knee are the most frequent injuries, and the 1st and 5th metatarsian are the zones that undergo the highest magnitude of pressures with the analysed soccer footwear for earth pitches.

KEY WORDS: soccer, earth pitch, comfort, pressure, footwear, injuries.

INTRODUCTION: The footwear normally used for football practise presents some characteristics that make it different to other sports footwear. Most of the research on this footwear has been based on the analysis of the football's practise in natural turf pitches. However, though most of Spain's footballers practise this sport on earth pitches, there are no studies directed to identify which must be the characteristics of the football boots for earth fields, which will require an independent analysis and research. For this project, generating a database of user's requirements has been planned as well as the identification of the most important aspects in the design of soccer footwear, the type of study and the characteristics of the shoe employed, as well as the identification of most frequent injuries suffered by the players who practise on earth pitches, how diverse shoe models distribute the pressures under the foot, the foot zones that undergo a greater pressure, and the assessment of the design aspects of the soccer footwear related to comfort.

METHODS: This study was structured in three phases: In the *first phase*, a survey was developed from the information obtained in several user and expert groups. This information allowed to obtain design-functionality characteristics of the boot and epidemiology associated to earth fields. The *second phase* of the study aimed to analyze the comfort of a football footwear sample which can be available on the market. The *third phase* allowed the analysis of the pressure distribution between the boot and the player's foot with the footwear they're used to play with on these fields.

a) *Horizontal Study; User-Experts groups and survey:* User panels are a method to obtain the perceptions of a group of people concerning the product. Based on a group interview technique, its objective is to identify possible improvements in all kinds of product features, based on buyers and users point of view. It tries to glimpse the origin of the problems and possible solutions (Page, A. and cols. 2001. IBV). The result of the panels allowed to create a data base of nonprioritized ideas of the necessities of the user, as well as to identify the most important aspects of the boot design. The information obtained, was very useful for the elaboration of a model of survey able to value the criteria of design and functionality of the boot, as well as for the most frequent epidemiology. A total of 280 questionnaires were completed with information from football teams of different categories and levels from all parts of Spain. The results obtained in the questionnaires were treated statistically by SPSS.10 (Statistical Package the Social Sciences).

b) *Comfort analysis:* The objective of this second phase was to identify, through questionnaires, the design characteristics of soccer boots regarding comfort and to detect the aspects correlated positively with the global evaluation of the boot. The Shackle (Shackle *et al.*, 1969) and Corlett (Corlett, 1981) procedure was used and based on three kinds of tests: general comfort, comfort in different parts of the body, and subjective opinion about

characteristics of products. Five regional football players tested a sample of seven football footwear with a high selling rate in the market and different design characteristics.

c) *Pressures study (BIOFOOT/IBV and BIOTRAT)*: During this third phase a study of the plantar pressures in different types of footwear was done by means of BIOFOOT/IBV. This is an advanced system of instrumented insoles designed to measure and analyze the pressures in the sole under real conditions, that is, with footwear and in motion. BIOFOOT/IBV provides a detailed and exhaustive analysis of the pressures registered during the measurement session. Allowing the automatic (animation) or manual advance through the measurement. This system can present the information in several formats (map of isobars, position and trajectory of the barycentre, three-dimensional map) or export the numerical data in a test file. The seven models used in the previous phase were analyzed with three regional football players, measurements were registered for three seconds and with a frequency of 250 Hz. This analysis was performed in two different ways;

1) By foot zones; with a distribution of 11 foot zones (Figure - 1). TLC.- central heel; TLI.-Internal heel; TE.- External heel; PLME.- External plant midfoot; PLMC.- Central midfoot; PLMI.- Internal plant midfoot; C5MT.- Head of the fifth metatarsian; MTM. - Metatarsian; C1MT.-Head of the first metatarsian; RDD.- Rest of toes; PrDD. - First toe) (figure - 1).

2) Point by point; The statistical processing of the data obtained from the Biofoot® was carried out using IBV software called BIOTRAT. The development of this software was based on the analysis approach exposed by Shorten (1999). The aforementioned programme is based on the processing of the data provided by the ceramics through an interpolated grid. Then, in every cell of the insole it is calculated the average of several strides for one or more subjects for a prototype. An ANOVA study is being done in order to find out if there are any significant differences in average pressure in each cell of the grid in the conditions studied ($p < 0.05$). The picture obtained represents the statistically significant differences according to a colour scale.

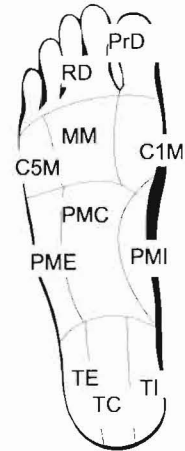


Figure 1. Scheme of the sole's plant distributed into zones.

RESULTS AND DISCUSSION:

a) *Horizontal study.* The results obtained show that comfort is one of the most valued aspects of the design and functionality characteristics of the boot, followed by the precision in the shoot and friction. About epidemiology, sprain of knee and ankle are the most frequent injuries in earth fields (figure - 2).

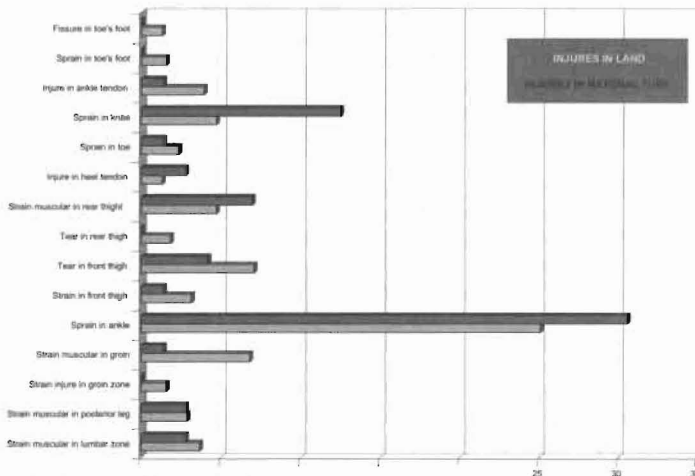


Figure 2. Most frequent injuries in soccer.

b) *Comfort survey.* The measurement of comfort in the different analysed boot models shows that there are significant differences among the analysed samples of boots, being the most valued boots the numbers 1 and 7. The analysis made it possible to find the most outstanding aspects in the general valuation of the boot and that there is a significant correlation of the behaviour of the boot in the game, annoyances on the toes, design of the studs, torsion and flexibility. In general, significant differences do exist among different boots, the most valued boots being numbers 2 and 7.

c) *Pressure distribution.* Different levels of pressure generated in the foot sole were identified, being the zones with greater pressure for all the analysed boots: the head to the 1st Metatarsian, the zone of the middle Metatarsians and the head of the 5th Metatarsian (figure-3). The analysis by means of the BIOTRAT allowed the comparison of pressures in different boots with a great space resolution (figure-4).

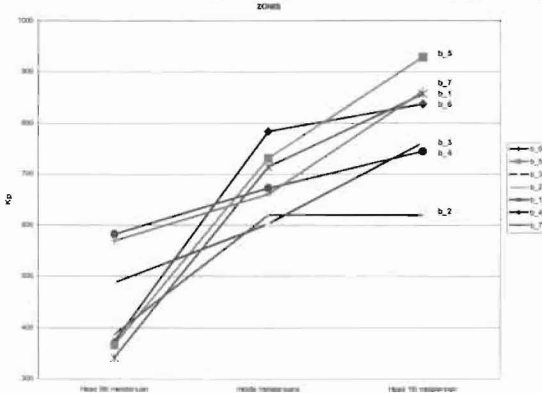


Figure 3. Average plantar pressures for the different boot models.

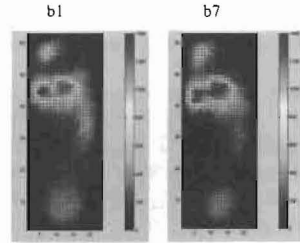


Figure 4. Comparison of the dynamic footprint of two feet.

CONCLUSIONS: The results let us know that aspects related to the perception of football footwear used in earth pitches that are most valued by the players are by order of importance the comfort, the hit precision and the surface and boot grab, as well as the added value characteristics of this kind of footwear. In addition the most frequent injuries on earth fields were identified. The plantar pressure analysis and the comfort perception of the players when they underpin the different sample models, have show the high pressure zones on the foot, coinciding with 1st and 5th Metatarsian heads, as well as with the median Metatarsian zone. The pressure patterns were obtained per piece of the sample models, patterns that have been related to the different design of the boots. That analysis made it possible to obtain design characteristics related to the higher pressures (that higher pressures could produce injuries in a short term), as well as the aspects more related with general valuation of the boots. The results obtained let us create new criteria oriented towards new soccer footwear design for earth pitches.

REFERENCES:

- Brizuela, G.; Ferrandis, R.; Ferrus, E.; González, J.C. Mejora de las prestaciones de las botas de fútbol. *Biomecánica. Cuadernos de información*. IBV. 1998.
- Brizuela, G.; Ferrandis, R.; Alcantara, E.; Martínez, A.; Forner, A. Biomechanical design of football boots: effect of studs on performance and injury prevention. *ISBS'98 XVI International Symposium on Biomechanics in Sports. Proceedings II*. 1998.
- Page, A.; Porcar, R.; Such, M.J.; Solaz, J.; Blasco (2001). Nuevas técnicas para el desarrollo de productos innovadores orientados. *IMPIVA-IBV*. Valencia.
- Shackel, B.; Chidsey, K.D.; Shipley, P. (1969). The assessment of chair comfort. *Ergonomics* 12(29):269-306.
- Shorten M. Et Al. (1999). 4th Symposium on Footwear Biomechanics (Canmore, Canada 5-7 August) 84-85.