PLANTAR PRESSURE MEASUREMENTS IN A SOCCER SHOE: CHARACTERIZATION OF SOCCER SPECIFIC MOVEMENTS AND EFFECTS AFTER SIX WEEKS OF AGING

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The purposes of the study were (i) to characterize in-shoe pressure distribution (PD) measurements during soccer specific movements, (ii) to describe the changes on (PD) after six weeks of aging. 21 experienced male subjects participated in the study. Four different movements (run, cut, sprint and goal shot) were measured on a red cinder surface before and after six weeks of aging. Results showed specific loading characteristics for each movement: Compared to running, the medial part of the foot in cutting, the forefoot in sprinting and the lateral part in kicking were predominantly loaded. Peak pressures increased over 10% after six weeks of use in some high-load areas. Attention should be paid to sprinting and cutting with respect to overuse injuries. Sockliners should be exchanged on a regular basis to maintain a certain amount of cushioning.

KEYWORDS: soccer, pressure distribution, overuse injuries, aging-effects, biomechanics, characteristics

INTRODUCTION: Overload injuries are a common problem in soccer (Knapp et al 1998). Although several investigations have described frequency and types of injuries (Inklaar 1994; Keller et al 1987; Tucker 1997) there is no quantitative information available concerning the foot loading characteristics in soccer specific movements. In addition, the effects of a regular use of soccer shoes on plantar pressure distribution also remain unclear. Therefore, the purposes of this investigation were:

- to characterize and compare in-shoe pressure measurements during different soccer specific movements,
- to describe the influence of a six week aging-process on plantar pressures distribution.

METHODS: 21 experienced male soccer players participated in the study. Their mean age, mass and height was 25.5±1.8 years, 78.7±5.4 kg and 182.9±5.7 cm, respectively. The Pedar Mobile system (Novel GmbH, Munich) was used to collect plantar pressure information. All subjects were fitted with new soccer shoes (with a typical 12-stud FG plate) and tested on a red cinder surface at the beginning and the end of a six weeks training period. During the six weeks, subjects wore the shoes on average two times per week on a regular basis. Four soccer specific movements were performed: a normal run at 4.1 m/s, a cutting maneuver at approximately 70% of maximum speed, a sprint and a goal shot. Peak pressures and relative loads were extracted for ten areas (medial and lateral heel (01, 02), medial and lateral midfoot (03, 04), medial, central and lateral forefoot (05, 06,07) and hallux, second toe and lateral toes (08, 09, 10), Fig. 1).

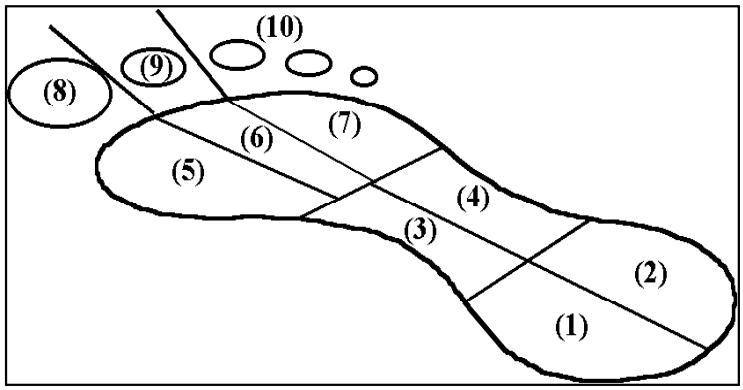

Figure 1 - The ten selected areas of the foot.

A repeated measures Anova with the alpha-level set to 5% and the Scheffe test for post-hoc comparisons were used for statistical analysis.

RESULTS: Different movements showed distinct pressure patterns (Fig. 2). Compared to the normal run, the cutting movement led to significant shift of load to the heel, midfoot, first metatarsal head and hallux (Fig. 3, left). In sprinting, load shifted significantly to the medial and central forefoot and the toes (Fig. 3, center). Under the supporting leg in goal shot, significantly increased values on the lateral part of the heel and midfoot were found (Fig. 3, right).

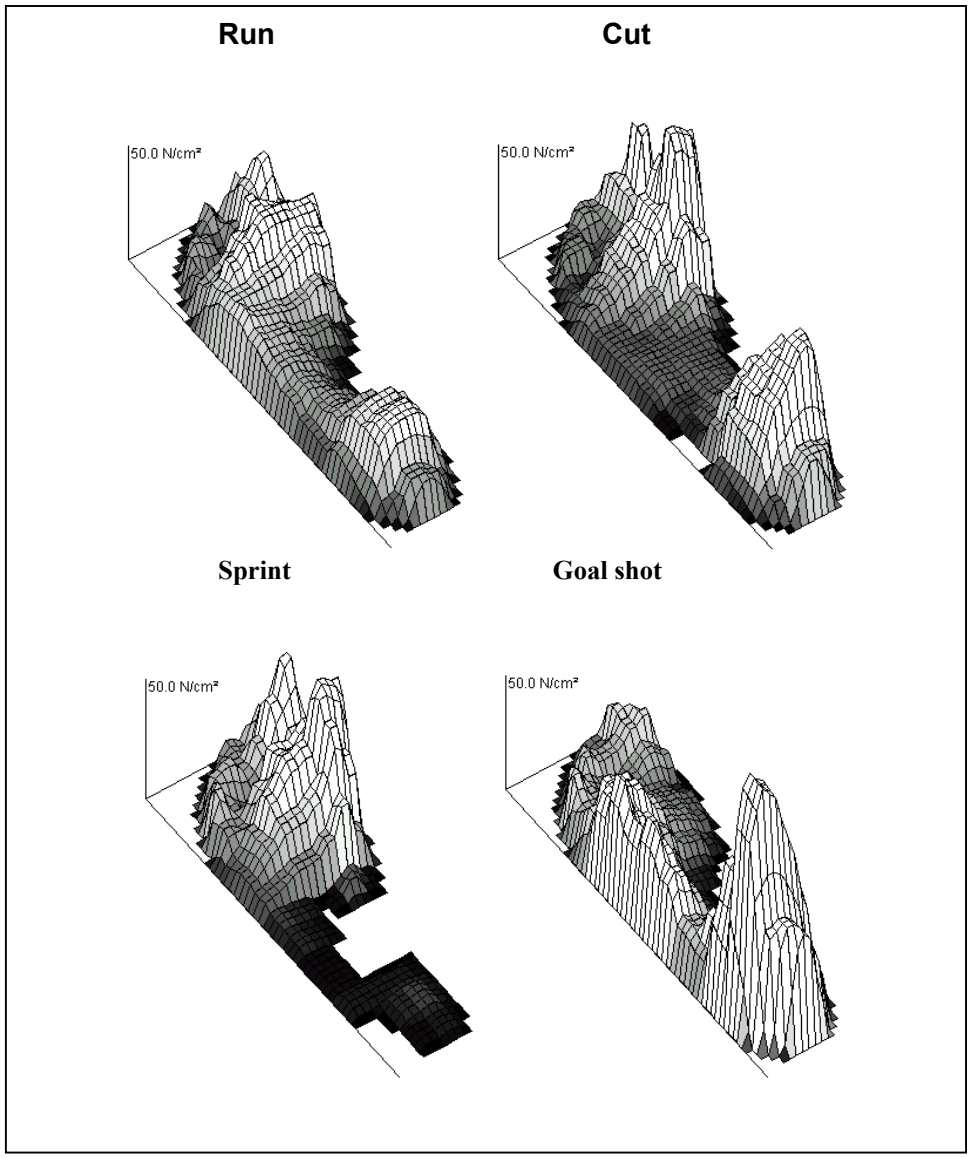

Figure 2 - Maximum pressure pictures of four soccer specific movements.

For the four different movements, extreme loading of specific areas was found (table 1). In running, a typical pressure pattern was found with the main loading areas under the heel, metatarsal heads and hallux. In cutting, the heel, first and second metatarsal head and hallux were exposed to high pressures. Pressures under the heel were twice as high as in running. In sprinting, especially the first and second ray were loaded and in kicking, highest pressures were found under the lateral part of the heel, midfoot and forefoot.

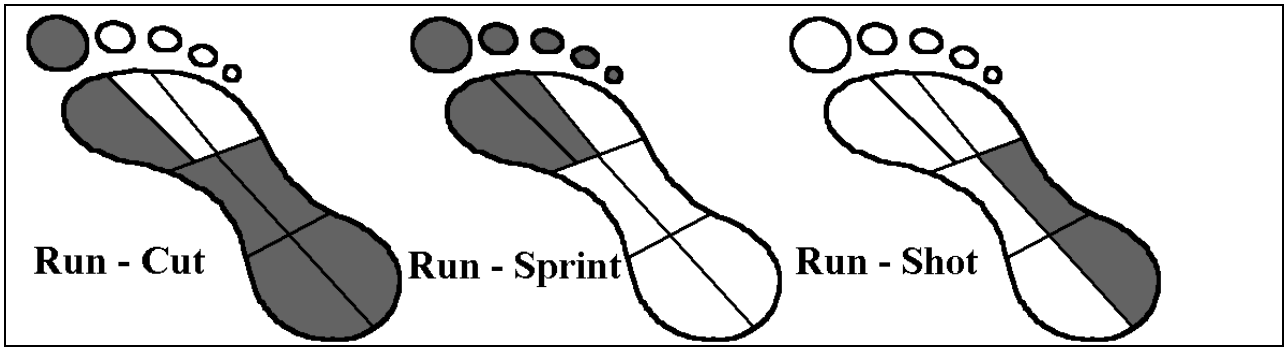

Figure 3 - Shift of load in soccer specific movements. The gray areas indicate a significant increase of load compared to running.

Table 1 Peak pressures for all areas (see text above) during the four soccer specific movements.

Peak Pressures [N/cm²]		Areas 01	02	03	04	05	06	07	08	09	10
Run	pre	31±6*	31±6	14±3	20±4	42±9	35±7	31±5	34±7	19±5	20±7
	post	34±6*	34±6*	20±16*	23±6*	45±13*	38±9*	36±7*	37±10	18±4	20±5
Cut	pre	61±14	46±9	23±8	19±6	62±13	30±6	14±3	47±9	22±7	17±5
	post	68±15*	49±11	32±15*	20±7	69±15*	35±7*	15±4	54±12*	23±7	18±5
Sprint	pre	6±2	6±2	6±3	10±3	60±18	42±8	30±7	50±15	26±8	23±6
	post	7±2	6±2	9±13	10±4	66±17*	46±9*	34±10*	53±17*	26±9	23±5
Shot	pre	65±11	72±14	26±10	36±9	31±11	32±9	40±9	38±10	26±8	27±8
	post	68±14	76±16	30±11	41±11*	34±11	35±10	45±14	39±10	26±10	28±8

'*' indicates significant differences between pre and post test at the 5% level.

The use of the soccer shoes for a period of six weeks led to an increase of peak pressures for most areas in all four movements. Significant differences were found especially in those areas that were characteristic for the different movements, i.e. the medial part of the foot in cutting, the forefoot in sprinting and the lateral part of the foot in kicking.

DISCUSSION AND CONCLUSION: The peak pressures for the normal run are higher compared to the values reported in the literature for running with similar speed (Chen et al 1994), clearly indicating the strong influence of a typical soccer shoe design on pressure distribution. The different soccer movements show very specific loading characteristics. In cutting, the medial part of the foot, in sprinting, the first and second ray and in kicking, the lateral part of the foot are extremely loaded. Despite the fact that the goal shot leads to extreme loading of the lateral anatomical structures of the foot, it should not be a main factor in developing overuse injuries because of the low frequency of occurrence during a soccer game. Instead, attention should be paid to the more frequent movements of sprinting and cutting in terms of overuse injuries and shoe or insole design.
A relatively short period of use led to an increase of peak pressures in some high-load areas of over 10%. This probably is not due to an aging effect of the shoe but might show the loss of cushioning of the sockliner inside the shoe. From that point of view, sockliners should be exchanged after a short period of use, or a compression resistant should be used to maintain cushioning and to reduce the potential of overuse injuries.

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