Flexible Studs in Prevention of Football Injuries
A Preliminary Laboratory Study

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1 INTRODUCTION

Lower limb injuries in football players can occur as a result of shock and impulsive stresses that can damage their organic tissues.

Despite increasing interest toward injury prevention little attention has been drawn to athletes equipment such as boots and studs, whose role in players performance and safety has been considered crucial.

The spikes and the sole of a shoe represent the interface between the body of an athlete and the soil and on this interface the applied forces and their reactions are concentrated. The choice of a correct stiffness of the spikes and of the sole allows the dissipation of the energy involved in the motion performed by the athletes. The spikes or the sole of a shoes can be realized as a composite system, where material featured by different mechanical characteristics are coupled to assure a correct mechanical reliability and stability and to realize the dissipation of the energy. Such composite systems have allowed the realization of spikes and sole whose mechanical features have been tested by instrumented machines in experimental laboratories in order to point out mechanical stability and attitude to energy dissipation possibly preserving athlete's health.

The purpose of this paper is to present preliminary results of laboratory tests performed on a new type of flexible studs designed to reduce risk of injuries in football and other outdoor sports (American football, rugby, field hockey etc.).

2 MATERIALS AND METHOD

The performances of the system designed and built for absorbing the energy associated to the impact of the athlete with the soil has been investigated by laboratory equipment that allows a control and systematic repeating of the loading cycle. The energy absorption of a traditional shoe equipped by a traditional sole and by a rigid aluminium spike has been used as a reference condition. A tensile machine has been modified in order to simulate the most frequent loading mode of the shoe sole and of the spikes imposed by the athlete motion. An universal traction/compression machine (MTS Alliance RF/150) equipped with dedicated devices built to allow vertical and oblique compression forces was used (see figures 1 and 2).

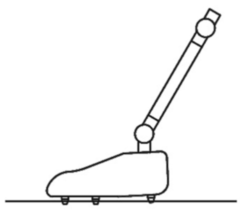

Figure 1.

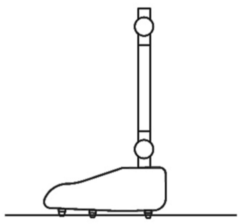

Figure 2.

Vertical and oblique forces were applied to either hindfoot and barefoot (figure 3 and 4) A 2 KN compression force has been applied at a speed of 10mm/min.

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Figure 3.

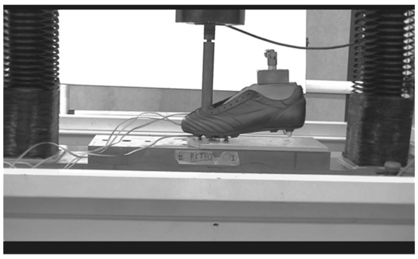

Figure 4.

The deformation of the inner side of the football shoe in the two main direction (longitudinal and transverse) has been measured by the application of four extensometers (HBM 1-xy18-3/350) attached on the inner side of the sole (figure 5).

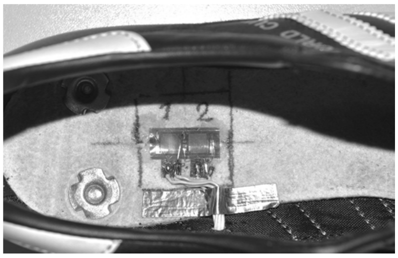

Figure 5.

The sole deformation has been measured as a function of the load and of the overall displacement imposed by the tensile machine. After the definition of such a reference condition, high deformable (flexible) energy absorbing spikes mounted on a traditional sole were tested using the same protocol. Five set of tests were performed on shoes equipped with both standard (aluminium) and flexible suds. Statistical analysis was performed with a student t-test; statistical significance was set with p<0.05.

3 RESULTS

Flexible studs significantly reduced stress and deformation in all the performed tests and of the inner sole as revealed by data collected by extensometers in both directions (longitudinal and transverse) (see tables 1,2,3).

Table 1: Mean sole deformation as a result of a vertical load applied to the hindfoot (p<0.05).

	Al 2kN [mm/mm]	Saspik 2kN [mm/mm]
1 Hindfoot Longitudinal	491 (11)	281 (17)
2 Hindfoot Trasversal	365 (13)	-216 (13)
3 Barefoot Longitudinal	886 (19)	89 (5)
4 Barefoot Trasversal	237 (7)	218 (7)

Table 2: Mean sole deformation as a result of a vertical load applied to the barefoot (p<0.05).

	Al 2kN [mm/mm]	Saspik 2kN [mm/mm]
1 Hindfoot Longitudinal	255 (8)	-78 (2)
2 Hindfoot Trasversal	302 (12)	-17 (2)
3 Barefoot Longitudinal	198 (4)	41 (4)
4 Barefoot Trasversal	821 (6)	395 (12)

Table 3: Mean sole deformation as a result of an oblique load applied to the hindfoot (p<0.05).

	Al 2kN [mm/mm]	Saspik 2kN [mm/mm]
1 Hindfoot Longitudinal	608 (21)	262 (9)
2 Hindfoot Trasversal	1244 (45)	120 (9)
3 Barefoot Longitudinal	2250 (39)	480 (15)
4 Barefoot Trasversal	414 (25)	242 (15)

4 CONCLUSIONS

On the basis of these preliminary laboratory data, use of flexible studs could result in a significant reduction of stress absorbed by athletes during sports activity, possibly reducing actual rate and severity of football and other outdoor sports injuries.

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