INFLUENCE OF FOOTWEAR ON THE ANKLE SPRAIN PRODUCTION MECHANISM IN BASKETBALL

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INTRODUCTION

Vertical jump is a usual movement in basketball. The frequency of this movement is related to certain injuries in sport, while these also relate to the type of surface, some personal features such as weight and height, and, mainly, to the features of the footwear worn.

Ankle sprain is the most frequent traumatic injury in sport activities, including basketball (Chan, 1993; Garrick, 1973; Petrov, 1988; Shapiro, 1994). In most cases, what causes ankle sprains is the sudden and forced inversion ocurring when the foot lands on an uneven surface such as another player's foot (Shapiro, 1994). One of the most usual ways in which ankle sparins occur is during landing after a jump; according to Sussman (1988) 31% of injuries in basketball occur during rebound actions.

Barefoot is capable of allowing the forefoot rotating with respect to the rearfoot, being this physiological movement a mechanism of adpatating to the ground irregularities. However, footwear limits this movement, called torsion, and causes pulling the rearfoot when the forefoot turns suddenly, affecting thus the ankle joint (Stackof, 1990). The injuries caused by this phenomenon are more frequent in sportsmen with a weakness located in this joint, and it is usually chronic. Footwear which favours inversion when landing after a jump, can also favour the overload of the muscles and ligaments which conform the joint.

It is usually considered as appropriate to support the ankle in order to diminish the influence of acute injuries which affect this joint (Barret, 1993). In basketball, the use of high top is wide spread among professional and amateur players.

The aim of this work was to determine the influence that the inclusion of different elements in footwear aimed at increasing ankle support has on ankle mobility when landing on an irregular surface after a jump.

METHODS

The study consisted in simulating a rebound action in which the player jumped and fell on an irregular surface, provided by a 20º test slope that forced the rearfoot to a supinated position. This slope enables us to study its effect without endangering the subjects.

Twelve shoe prototypes were made, each combining different elements of construction, obtaining thus eight high top and four low top shoes, six with heel counter stabilizer and six without it, six with hollow midsole at midfoot level and six without it, and finally, for high top shoes, four with lace anchors and four without them.

Among the elements mentioned, high top, heel counter stabilizer and lace anchors are included to limit rearfoot movements, while the hollow midsole is intended for making the midsole flexible, increasing the mobility between forefoot and rearfoot.

Three healthy male subjects were selected; they were Physical Education students and regular basketball players. They performed a total of 36 jumps each, on a test slope. These jumps were grouped in series of three jumps each, with a recovery time of 30 seconds between jumps and of 3 minutes between series. During each series, the subject was wearing one of the twelve prototypes, in a random sequence. The subjects jumped and landed with one of their foot on the test slope. The jump height was fixed at the 95% of the subject's maximum jumping ability, measured in a test where he jumped and tried to reach with both hands.

Before carrying out the test, the subjects were marked, following a 9-marker model, and limiting three rigid solids: thigh, leg and foot. Each jump was filmed at 150 Hz and later manually digitized frame to frame. After being digitized, the 3D coordinates for each markers were calculated using the DLT method. By using quintic splines smoothing and the JCS (Joint Coordinate System) model, the angles for knee flexion-extension, and ankle flexion-extension and eversion-inversion were calculated as a function of time.

Of all the variables analyzed, the following parameters were selected for the kinematic analysis: minimum ankle flexion angle, maximum ankle flexion angle, maximum eversion angle, maximum inversion angle. With these parameters it was made an Analysis of Variance (ANOVA), taking as factors the different elements included in the footwear as well as the subjects. α of 0,05 was chosen as significance level.

RESULTS

The results obtained from the kinematic analysis indicate that the high top shoes limit the range of movement during ankle flexion-extension. Besides, higher values of rearfoot inversion were found with them. This effect is increased when a heel counter stabilizer is added to high top prototypes. On the contrary, a hollow midsole showed to produce lower levels of inversion. The inclusion of a rearfoot-movement control system by means of lace anchors in high top shoes did not seem to have an influence in the movements studied.

With low top shoes, greater values of eversion were found, occurring immediately after heel contact. However, the maximum values recorded were within the normal range of movement.

CONCLUSION

According to several epidemiological studies, high top shoes should reduce the incidence of acute ankle injuries. However, the results obtained significantly show that, after landing on an uneven surface, both the high top and the heel counter stabilizer increase the inversion level. This fact can be understood if we consider that, when landing after a jump, and bending the hip, knee and ankle, there is also an inclination of the tibias that results in the knees getting closer. This inclination causes, even when landing on an even surface, a determined level of inversion, measured between rearfoot and tibia. In the case of the slope, these extra degrees of inversion are added to the 20º of the slope, causing greater or lesser inversion, depending on whether more or less adherence of the rearfoot to the ground is there. So, the more vertically rigid a trainer is at rearfoot level, the greater adherence there will be to the ground or slope on which the subject falls, and the greater the inversion level there will be (figure 1).

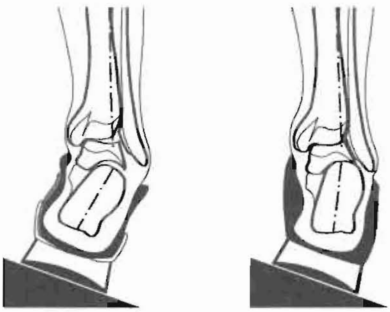

Figure 1: Possible effect of an heel counter on foot inversion during landing on an uneven surface after jumping. Left: with heel counter (higher inversion); Right: without heel counter (lower inversion)

In this sense, the high top and the heel counter stabilizer are elements which favour a greater final inversion in this situation. On the contrary, a hollow midsole in high top shoes increases their transverse flexibility, allowing the rearfoot to move along with the tibia in its lateral inclination, obtaining lower values of final inversion. In the case of the heel counter stabilizer, which only increases the shoe vertical rigidity but which offers no extra support for the ankle joint, it could have been expected that the greater inversion that occured during landing after a jump increased the risk of an ankle injury. According to the results analyzed and applying them to the study of jumps, some recommendations can be made for designing or chosing the appropriate footwear. High top shoes should not include a heel counter stabilizer in the inner side of the rearfoot. If more support is desired and this should be provided by a heel counter, this should be included only in the outer side of the rearfoot. In any case, a hollow midsole is recommended. For those players who prefer low top shoes and who perform several displacements when running, the shoes could include a heel counter similar to that used in running shoes to avoid hyperpronation.

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