INFLUENCE OF BONDINGS FOR THE LACING; BACKERS AND HEEL COUNTERS OF THE FOOTWEAR IN THE PRONOSUPINATION MOVEMENT IN RUNNING

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INTRODUCTION

The relationship between the excessive pronation and some of the most common injuries in runners has been extensively studied by several authors (James, 1978; Clement 1981; Subotnick, 1985). In the same way, the limitation of torsion angle has also been related with injuries. It has been proved (Stacoff, 1989) that as the rigidity of the footwear increases, lower torsion angle variations are obtained. However, in literature, there are few studies about the upper vamp.

The purpose of this paper is the study of the effect of some elements of the upper vamp on the pronation and torsion of the foot.

METHODOLOGY

In order to study the aforementioned elements, six prototypes were designed and manufactured (figure 1). Besides, a selection of subjects was done by means of screening long distance runners. Ten subjects that showed hiperlax planus valgus feet were selected (7 men and 3 women). It was assumed that those subjects would be more sensitive to any change made in the sportshoes because of their articular mobility.

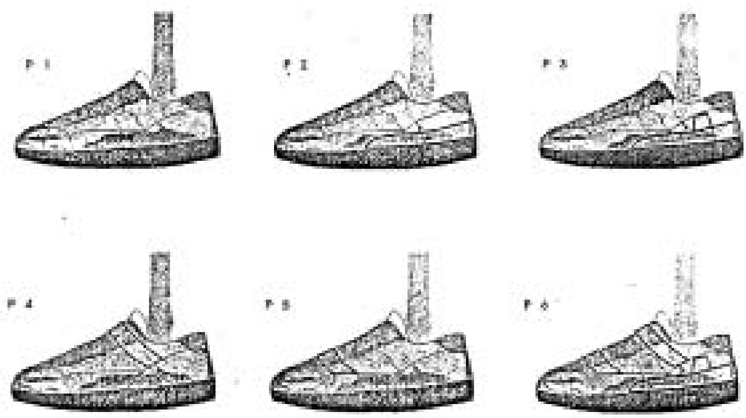


Figure 1: P1 prototype without movement control elements. P2 prototype with external heel counter. P3 prototype with external heel counter and a post as backer in the internal back of the sportshoe. P4 prototype with a lace anchor from the last eyelet of the lacing. P5 prototype with lace anchor from the first eyelet of the lacing. P6 prototype with all the elements in the same shoe.

Once the subjects had been selected and the prototypes manufactured, a kinematic study of the rear plane was performed. The experiences consisted of filming three consecutive running supports on a treadmill at an speed of 8 miles per hour (12.8 Km/h), beeing this velocity the submaximal one for all the subjects. The speed of filmation of the camera was fixed at 85 frames per second.

In order to minimize errors due to runner's technique, a time period of 10 minutes for adaptation of the runner to the treadmill was taken as well as 5 minutes for adaptation to each prototype tested. In all cases a uniform step length and accomodation to running speed was ensured. Previous video recordings were made to establish the external rotation angle of the foot and to place the filming camera perpendicular to the plane where the pronosupination of the foot occurred (Areblad, 1990). Both subjects and sportshoes were marked according to the six points, three segments and two angles model used by Stacoff.

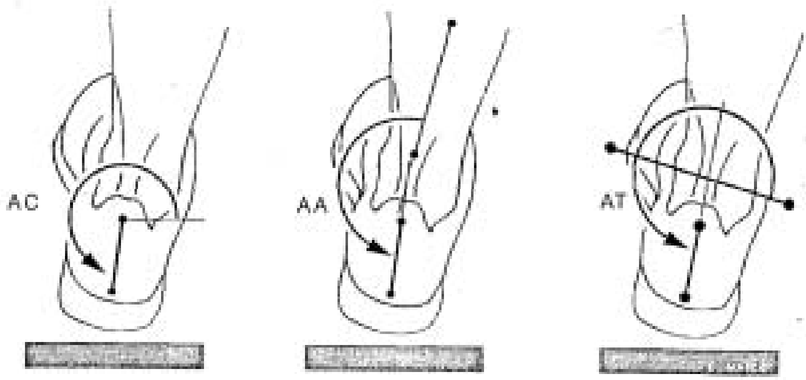


Figure 2: Calcaneum angle (AC) between calcaneum segment and horizontal. Aquiles angle (AA) between the tibial and calcaneum segments. Torsion angle (AT) between calcaneum segment and forefoot.

After the films had been digitalized, data were processed by means of a specific software developed by the IBV. Parameters obtained are: positions, .velocities and accelerations of markers, segments and angles between segments. For this study three instants were defined. "Initial Contact" (IC) refers to the moment when the sportshoe first contacts with the floor. The "Total Contact" (TC) refers to the moment when the whole sportshoe contacts with floor. "Heel's take off' (HTO) is defined as the moment when the back of the sportshoe loses contact with floor.

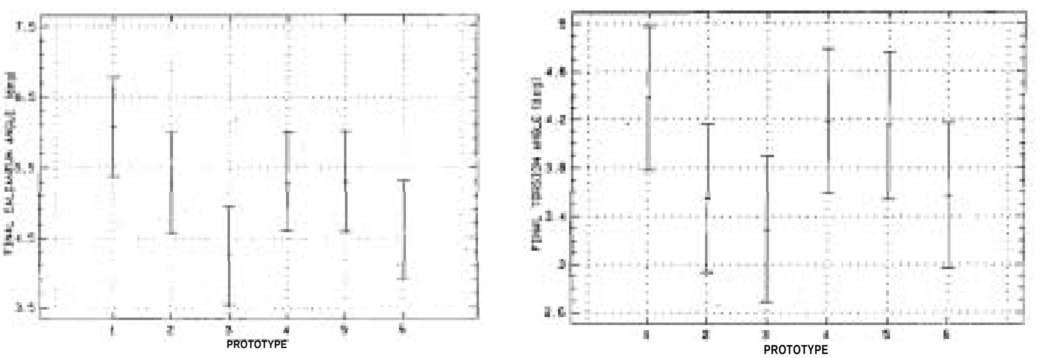
We call "Initial Period" to the interval between Initial Contact and Total Contact and "Final Period" to the interval between Total Contact and Heel's take off. In the first part of this final period the rearfoot pronation continues. Although pronation occurs at lower speeds can be very important in the occurrence of injuries (we have found maximum values of till 20 degrees in some of the subjects of this study). Finally, we call "Total Movement" to the two periods as a whole between Initial Contact and Heel's Take off, although it is known that the foot moves after and before those moments.

In order to make a statistical treatment of the data, several variables were defined. All the variables represent variations between the first value of the angle in the period considered and the maximum value in the same period. The angles considered are defined in figure 2. The statistical treatment was done considering variables related with the initial period (initial aquiles angle variation, initial calcaneum angle vanation, initial torsion angle variation), with the final period (final aquiles angle vanation, final calcaneuin angle variation, final torsion angle variation) and with both periods as a whole (total aquiles angle variation, total calcaneum angle variation, total torsion angle variation).

RESULTS AND DISCUSSION

With each of these variables an analysis of variance (ANOVA) was done. As **was** expected, the variables corresponding to the initial period (between initial contact and total contact), don't show statistically significant differences between the different prototypes. This is owed to the fact that the movement occurring during this period can only be changed modifying the form or the materials of the sole and midsole. As previously mentioned, all the prototypes have equal design of the form of the sole and materials.

Variables that describe the whole movement from the initial contact to the heel's take off, although in several cases showed differences between the prototypes, have not been considered. This is owed to the fact that the elements included in the upper vamp were not going to modify significantly the total amount of movement but limit the last degrees of the movement in the final period that can be the more injurious for the musculo-skeletal system.



a) b)

Figure 3: Mean level and significance intervals of the final calcaneum angle variations a) and final torsion angle variations b).

The variables corresponding to the final period (between the total contact and the heel's take off) showed significant differences between the tested prototypes. The values of the aquiles angle variations showed that prototypes P2, P3 y P6 (all with external heel counters) reduced the movement with respect to P1 (prototype with no elements in the upper vamp). P4 and P5 showed similar values to P1 ($p < 0.04$). The values of the calcaneum angle variations obtained showed that the P3 and P6 prototypes (with post) were the ones that most limited the pronation (figure **3** a)). Prototypes P2, P4 y P5, with values very similar between them, did not limit the pronation so clearly ($p < 0.01$). Values regarding to torsion angle variations, although with a lower level of statistical significance ($p < 0.07$), showed that P2, P3 and P6 lowered the torsion, while P4 and P5 had a behaviour similar to P1 (figure 3 b)).

CONCLUSIONS

Prototypes not including rearfoot control permit a higher pronation and a higher torsion between rearfoot and forefoot. The isolate use of external heel counters placed between the midsole and the upper vamp in the back of the shoe doesn't permit to assure a good rearfoot control and however lowers the torsion movement. Including a post in the internal rear part of the shoe associated with the heel counter is very effective to limit the pronation without increasing the shoe stiffness (comparing with the prototype with had only a heel counter). The inclusion of backers for the lacing limits the pronation as much as the external heel counters, without lowering the torsion movement.

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