Evaluation and analysis of the footprint of young individuals. A comparative study between football players and non-players

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Summary

We report an evaluation, using a pedigraph, of young football players (n=100) belonging to the juvenile and amateur categories (16-25 years) from two football clubs in Salamanca, carrying out a comparative study with the results obtained in a population of university students (n=37) of similar chronological age who did not practice any officially federated sport. From the footprint, we calculated the Chippaux index and the Clarke angle. To complete the study, we obtained an assessment of the calcaneus-tibia angle under load using a goniometer.

The results point to homogeneity among the groups as regards the parameters measured on the footprints (Chippaux index and Clarke angle). Thus, all three groups had a normal foot according to the Clarke angle, while the Chippaux index reflected a normal left foot and an intermediate right foot according to the Horawa and Jawroski classifications.

In contrast, heterogeneity was seen for the hindfoot angle, with a tendency towards physiological valgus in the right foot, while the left foot showed values close to neutrality for that parameter.

Key words: Footprint – Pedigraph – Football – Hindfoot – Young adult

Introduction

Much has been published about the health-sports relationship and about the influence of physical activity in childhood, adolescence and young adulthood as regards several physiological parameters. These relationships have led to the need to perform periodic assessments to monitor such parameters, thereby determining the most frequent alterations arising in the organism (Blasco, 1997; Garzarelli, 2002; Marcos et al., 1995; Marín et al., 1995; Santoja and Martínez, 1992). It has been reported that overuse of one foot, due to technical factors and taking into account the body composition of the sportsperson, leads to the appearance of *acute* biomechanical adaptations in pre and post-competition situations (Sirgo and Aguado, 1991). It is appropriate to consider that such acute biomechanical adaptations arising when the sportsperson is challenged by effort will over time become chronic, meaning that the structure of the foot may acquire a specific configuration, depending on the sports modality engaged in (Sirgo et al., 1997).

In this sense, within the context of sports activities use of the foot as an essential element in the practice of football can be considered a paradigm of over-demand. The biomechanical demands to which the foot is subject when kicking the ball, the use of special and specific footwear, and the differing terrain of the different sports fields (packed earth, grass, etc) acti-

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vate a series of muscles and joints that in daily life do not work with the same intensity or mobility, respectively (Velamazán et al., 2000).

Explorations aimed at identifying these alterations (according to the IFMS (International Federation of Sport Medicine) should include an examination, both static and dynamic, of the locomotor system, in which plantar support would be encompassed.

Examination of static plantar support has been carried out in many ways. As well as providing biomechanical data, such explorations are undoubtedly of help for morphostatic diagnosis, identifying the behaviour of the foot on its support platform (Lavigne and Noviel, 1993). Among the explorations most commonly implemented is the recording of the imprint corresponding to the footprint. This method has the advantage of affording a graphic document for the future clinical history of the individual, which will allow the evolution of the internal longitudinal arch (among other parameters) and the performance of some calculations of measurements that facilitate the classification of the foot within the main types of static prints to be monitored. Pedigraphy is a good method for the analysis of footprints because it is cheap, easy to use and fast (Goldcher, 1992). This imprint provides an objective and informative document that allows researchers to make comparison over time, and it also affords information about the hierarchies of the pressures affecting the plantar surface. The method is also useful in the confection of foot prostheses (Lavigne and Noviel, 1993). The sensitivity of the mat allows it to react to a minimum pressure of 80g/cm^2 (Martínez, 2000).

Classical anatomists have compared the physiological plantar arch to a tripod (formed by two longitudinal arches, external and internal, and another transverse one); to a helix; to an arch, and to a vault (with posterior and anterior support), although currently there is no general consensus among the different authors as regards matching it with any known architectural model. In contrast, it is known that the foot is a structure in continuous evolution that does not complete its skeletal development until the definitive maturation of the person, affording a major mechanism of compensation of both axial alterations of the lower limb and for deambulation over different types of surface. In this sense, rather than speaking of a "normal foot" at a given age, the concept of "developing foot" or "balanced foot" should be invoked, mainly as regards the development of the individual (Goldcher, 1992; Ruiz et al., 1996; Santonja and Martínez, 1992; Sirgo et al., 1997; Viladot, 2002a; Zurita, 2002).

Although within analyses of the footprint there are many definitions and classifications of alterations to the feet, the one based on two principal components -flat foot and concave foot- is widely accepted.

In general, a foot is said to be flat when there is an increase in plantar support; that is, a decrease in the height of the arch. For Rochera (Viladot, 2002a) or Lelièvre and Lelièvre (1992) this alteration is characterised by a valgus of the heel and hypotonia of the plantar muscles. This valgus of the heel is the first step in breaking the equilibrium of the plantar arch and its movement the calcaneus drags the talus, which moves forwards, downwards, and inwards, leading the internal longitudinal arch to collapse. For Viladot (2002a), the flat foot is not a collapsing bridge but a helix that unfurls: two rotatory movements that are the inverse of each other. There is a pronation (dorsal flexion, eversion and abduction) of the hindfoot and at the same time a supination (plantar flexion, inversion and adduction) of the forefoot.

The concave foot, by contrast, shows a decrease in plantar support; that is, an increase in the height of the arch. This is usually accompanied by a clawed aspect to the toes and a varus deviation of the calcaneus. It is this latter point, perhaps, that is the most debatable since according to different analyses it is common to encounter calcaneus valgus with decreased supports, and hence compatible with the definition of concave foot. This is due to the frequent appearance of concave-valgus feet, in which the internal and external edges do not contact the ground (they do not appear on the footprint), leaving a central zone of the arch absent from the imprint. The situation is that the arch tends to drop through its internal part, but before reaching the support surface, it has raised the external arch (Viladot, 2002a). Accordingly, this means that an additional measurement of the footprint is necessary. This measurement corresponds to the hindfoot angle or calcaneus-tibia angle, as reported by different authors (Baticle et al., 1997; Ruiz et al., 1996). The exploration described by most authors is carried out under conditions of bipedestation, on an anthropometric bench, with both heels separated on the edge of this, obtaining the so-called *Helbing line*. The reference value in the literature is of a physiological valgus of 5-10º of the heel with respect to the axis of the leg (Delarque et al., 1998; Santonja and Martínez, 1992; Viladot, 2002b).

To graduate these alterations, in the footprint it is possible to carry out different analyses, the following being among those most commonly implemented.

The Chippaux index (Chippaux, 1947; Llanos et al., 1976; Gómez et al., 1991; Martínez, 2000; Santonja and Martínez, 1992; Viladot, 2002b), and the Clarke angle (Martínez, 2000; Martorell, 1997) are used both for monitoring the development of the internal longitudinal arch of the foot and for the diagnosis of flat feet, since the index relates the transverse diameter of the anterior zone of the foot to the transverse diameter of the isthmus of the foot. The reference values for the classification of the types of foot according to Bavor and Horawa, and Jawroski (cited by Martínez, 2000, and Saavedra, 2000) are shown in Table 1.

Table 1.- Classification of Bavor and Horawa (1974) and Jawroski (1987). Cited by Martínez, 2000, and Saavedra, 2000.

Type of foot	Clarke angle (degrees)	Chippaux index (percentage)
Normal foot	42—50	1-29.9
Intermediate foot	35-42	30-39.9
Fallen arch	30-34.9	40.44.9
Flat foot	0-29	>45
Concave foot	0	0

Materials and Methods

Subjects

We assessed a total sample of 137 males with an age between 16 and 25 years. These were divided into two groups. The first group included 100 young footballers belonging to two football clubs in Salamanca (Spain) who showed differences in regard to the type of training exercises, physical training and leagues or type of sports terrain (packed-earth, grass…). The criteria for inclusion in this first group were as follows. First, the individuals had to belong to each of the sports categories described below, this being accredited by a federation card (the number of players examined corresponds to the total sample of each of the categories included in the study who fulfilled the criteria). A second criterion for inclusion was regular attendance at training sessions, this information being provided by the coach. As a criterion for exclusion, we took into account the existence of lesions that might hinder satisfactory performance in our physiotherapeutic assessment. Of the total number of players, 52 were in the Third Division (a branch of the professional UDS-SAD team of the Second Division), the Juvenile Division of Honour and the Juvenile of the National League of the *Union Deportiva Salamanca* club (UDS "B" SAD) teams, while the 48 remaining players were in the *Regional Preferente*, and *Juvenil Provincial* of the *Union Deportiva Santa Marta club* (UD-Sta Marta) teams. Dividing the footballers by sports categories, 61 were juveniles and 39 belonged to the amateur category. Additionally, even though these players are not considered to be professionals in the sport, their weekly dedication is high, with more than 12 hours spent practising.

The second group (non-players) was formed by 37 university students from the Diploma degrees in Nursing and Physiotherapy of the University of Salamanca, with a chronological age similar to that of the amateur players' group with which the comparisons were to be made (which is why the non-player group contained a similar number of subjects to the player group). The main criterion for inclusion in this group was the fact that they had not practiced any federated sport over the previous few years.

Methodology

A transverse descriptive observational study (or study of prevalence) was carried out on the above population, performing an individual physiotherapeutic evaluation -after informed consent- designed and specified on a form common to both study groups.

The first section contained personal information and any other data of interest for our study, paying attention to the years spent by the players practising football and their backgrounds as regards possible lesions, because these could constitute criteria for exclusion. We also collected data, within the general section of estimations, on the weight (kg) and height (cm) of each subject.

The footprints were obtained by placing a reticulated piece of rubber sheeting, tensed and impregnated with ink, between the subject's foot and a piece of stretched paper. The sensitivity of the mat allowed it to react to a minimum pressure of 80-100g/cm^2. The measurements taken on the imprint were the Clarke *angle* and the *Chippaux index.*

The Clarke angle is formed by the line tangent to the inner edge of the foot with another line tangent to the medial-most part of the footprint, which has its origin at the point of contact between the line tangent to the internal edge and the digito-plantar eminence.

To calculate the Chippaux index, the same line tangent to the internal edge of the footprint is drawn. From the point of contact of this line with the digito-planar eminence, a line is drawn that crosses the eminence through its broadest part. Then, a line is drawn parallel to the previous one that passes through the narrowest point of the isthmus of the sole of the foot. The index is the quotient obtained on dividing the value of the isthmus line by the value of the breadth line of the forefoot, expressed as a percentage (Núñez-Samper and Llanos-Alcázar, 1997).

The angle of the hindfoot, or calcaneus-tibia angle, was carried out while the subjects were standing on an anthropometric bench, with both heels separated at the edges of the bench. Thus, first the line of traction of the Achilles' tendon, its point of insertion at the level of the calcaneus bone, and the mid-point of the contact of the heel with the bench were marked with a dermographic pencil. Then, on both lower limbs a goniometer was used to measure the angle formed by the intersection of an imaginary line joining the point marked on the calcaneus with the traction axis of the Achilles' tendon and the line joining the same point marked on the calcaneus with the mid-point of the contact of the heel with the bench.

Under normal conditions, the three points belong to the same reference line, called the *Helbing line*, which passes through the centre of the popliteal region and ends at the mid-point of the point of contact of the heel. However, the normal reference value is a physiological valgus of 5º-10º. In contrast, values appreciably higher than this are indicative of a pathological valgus and, likewise, negative values imply a hindfoot varus (Delarque et al., 1998; Núñez-Samper and Llanos-Alcázar, 1997; Santonja and Martínez, 1997; Viladot, 2002b).

All the tests were carried out with the individuals barefooted and in their underclothes and were always performed by the same physiotherapist in each, thereby minimising interobserver errors.

Material

The measuring instruments used in the present study were an anthropometric bench (Psymtec); a rubber mat pedigraph (Globis Berkemann), a simple goniometer (*Enraf Nonius,* precision 2º) and a dermographic pencil and a millimetre ruler.

Statistical methodology

The variables determined were analysed using the SPSS version 11.0 statistical program. We calculated the means, standard deviations and frequencies corresponding to the descriptive analysis, using *Student's t test for independent samples* ($p<0.05$). In the analysis of bivariate correlations, *Pearson's correlation coefficient* was used ($p=0.01$).

Results

1. Descriptive results

1.1. General data. Variables: age, weight, height, years spent practising sports.

The mean *age* was similar for the three main study groups and was higher in the case of the amateur players subgroup, with a value of 21.26 years. The *weight* and *height* of the total sample assessed were 72.9 kg and 175 cm, respectively. These values were similar for both player groups but appreciably higher in the case of the "non-players", who were heavier and taller. The mean values of the *years spent practising sports* variable were relatively high in both groups of players, this being indicative of the high degree of early specialisation to which the players had been subjected (Table 2).

Table 2.- Descriptive results: general data on the study population.

GENERAL DATA ON THE POPULATION STUDIED					
	UDS-SAD N=52	*UD St.Marta* N=48	*"Non-player" group* N=37	*Juveniles* N=61	*Amateurs* N=39
Age years)	18.77 ± 2.10	19.00 ± 2.74	20.00 ± 2.48	17.41 ± 0.99	21.08 ± 1.91
Weight (Kg)	72.22 ± 7.82	71.62 ± 7.91	75.61 ± 8.48	70.67 ± 7.86	73.92 ± 7.47
Height (cm)	174.52 ± 5.72	173.69 ± 6.24	177.23 ± 6.05	173.10 ± 6.27	175.74 ± 5.12
Years spent practising sports (years)	9.25 ± 2.60	9.69 ± 2.77	-	8.2 ± 1.82	11.44 ± 2.62

Value: Mean ± standard deviation

1.2. Evaluation of footprint. Variables: Clarke angle and Chippaux index

Regarding measurement of the *Clarke angle*, the resulting mean values were almost analogous for all three study groups, in both sports categories evaluated, and for the footprints of both feet (table 3). Thus, the mean of the total study sample (48.1 ± 8.7º and 47.8 ± 9.8º for the left and right foot, respectively) indicates a footprint corresponding to a "*normal foot*", according to the classifications of *Horawa and Jawroski*.

Regarding the total sample evaluated, the mean values for the *Chippaux index* were 29.2 ± 9.9% for the left footprint and 31.0 ± 9.5% for the right foot. According to the classifications of *Horawa and Jawroski*, the results afford a footprint corresponding to a *normal left foot* and an *intermediate right foot*. The same conclusion was drawn from the descriptive analysis by study groups and by football categories, whose mean values were very similar.

1.3. Evaluation of the alignment of the hindfoot. Variables: left calcaneus-tibia angle and right calcaneus-tibia angle

As may be seen in Table 3, the results of the descriptive analysis of the alignment of the hindfoot point to a considerable difference between the mean values of both lower limbs. Thus, in both the analysis of the total study sample (8.2 ± 4.3º) and in the analysis by study groups (7.7 ± 4.3º "non-players"; 8.7 ± 4.8º UDS-SAD and 8.0 ± 3.7º UD Sta Marta) and by sports categories (9.0 ± 5.1º amateurs; 8.6 ± 3.7º juveniles) the mean values were always greater for the *calcaneus-tibia angle* of the right foot, within the defined physiological valgus of 5º-10º. In contrast, the mean values corresponding to the *left hindfoot* were lower than the reference physiological valgus, except for the UDS-SAD players (5.4 ± 6.4º) and approximately zero or neutral for the hindfoot angle in the case of the "non-players" (1.4 ± 5.5º). It should be noted, however, that the high standard deviations of the values obtained point to the heterogeneity of the results in the evaluation of these variables.

2. Comparative results

Bearing in mind the aim of the present study, a triple comparative analysis was carried out on the following groups:

A) Footballers and "non-players", selecting only the groups of amateur footballers owing to the greater correspondence with respect to the stage of growth with respect to the "non-players".

B) Both football clubs: all the footballers from the UDS and all those from UD Sta Marta.

C) Both sports categories: juvenile footballers and all amateur footballers.

Table 3.- Descriptive analysis: alignment of the hindfoot and evaluation of the footprint.

	UDS-SAD *N=52*	***UD St.Marta*** *N=48*	***"Non-player" group*** *N=37*	***Juveniles*** *N=61*	***Amateurs*** *N=39*	***Total sample*** *N=137*
FOOTPRINT: Clarke angle						
Left Ft.	47.9 ± 8.9	48.6 ± 8.9	47.9 ± 8.4	48.4 ± 8.7	47.9 ± 9.1	48.1 ± 8.7
Right Ft.	47.2 ± 10.8	48.7 ± 9.9	47.5 ± 8.5	48.3 ± 10.4	47.3 ± 10.4	47.8 ± 9.8
Mean ± standard deviation in degrees.						
FOOTPRINT: Chippaux INDEX						
Left Ft.	28.8 ± 10.7	29.7 ± 8.5	29.0 ± 10.5	29.3 ± 9.0	29.2 ± 10.7	29.2 ± 9.9
Right Ft.	30.5 ± 9.6	31.3 ± 8.7	31.5 ± 10.6	31.2 ± 9.6	30.4 ± 8.7	31.0 ± 9.5
Mean ± standard deviation in degrees.						
ALIGNMENT OF HINDFOOT: calcaneus-tibia angle						
MI izq.	5.4 ± 6.4	2.5 ± 4.9	1.4 ± 5.5	4.0 ± 5.9	4.1 ± 5.9	3.3 ± 5.8
MI dcho.	8.7 ± 4.8	8.0 ± 3.7	7.7 ± 4.3	8.6 ± 3.7	9.0 ± 5.1	8.2 ± 4.3
Mean ± standard deviation in degrees.						

Based on an analysis of the results obtained, it was deemed of interest to complete the comparative study with a brief analysis of the possible bivariate correlations between the different variables defined in the alignment of the hindfoot and examination of the footprint.

D) Bivariate correlations: evaluation of both footprints according to the *Clarke angle* and *Chippaux index* and the relationship of these parameters: alignment of both hindfeet.

A) Comparison between footballers and "non-players"

As may be seen from the comparative results shown in Table 4, there were no statistically significant differences for the *age, weight* and *height* variables of these two study groups.

Students t test applied to the variables corresponding to the footprint did not reveal statistically significant differences between either study group. These results confirm the similarity between footballers and non-players with respect to the evaluation.

Finally, differences were found in the evaluations of the alignment of the left hindfoot, in which the *left calcaneus-tibia angle* was considerably smaller in the non-players group (1.4 ± 5.5º) with respect to the footballers and lower than the normal physiological reference valgus.

B) Comparison between UDS players and UD Sta Marta players

No statistically significant differences were observed for the variables age, weigh, height and years spent practising sports between the two groups of players (Table 5).

Neither were there any statistically significant differences between the two groups studied as regards comparative analysis of the variables corresponding to the examination of the footprint.

Finally, comparative analysis of the evaluation of the *calcaneus-tibia angle* only revealed differences with respect to the left foot. Thus, the value of this angle proved to be smaller for the UD Sta Marta players.

C) Comparison between amateur and juvenile players

The results of the comparison of the general data pointed to statistically significant differences as regards *age, weight, height* and *years spent practising sports* in the players of both categories (Table 6). Thus, the amateur players were older (21.1 ± 1.9 years), heavier (73.9 ± 7.5 Kg), and taller (175.7 ± 5.1 cm). Likewise, their "sports life" (years spent practising sports) was significantly longer (11.44 ± 2.62 years) than that of the juvenile players.

Student's t test revealed differences between both categories of players as regards the evaluation of the plantar imprint. Thus, the above-described homogeneity persisted with respect to the *Clarke angle* and the *Chippaux index.*

No statistically significant differences were found with respect to the measurement of the calcaneus-tibia angle, although the mean values continued to be higher for the angle of the right foot, both in the juvenile players (8.6 ± 3.7º) and in the amateurs (9.0 ± 5.1º), within the normal physiological reference valgus.

D) Analysis of bivariate correlations

In the analysis of the plantar imprint, both the *Chippaux index* and the *Clarke angle* corresponding to the right foot had a positive linear and high

Table 4.- Comparison between players and non-players.

COMPARISON BETWEEN PLAYERS AND NON-PLAYERS	
VARIABLE	*Student's t test*
Age	$_{0.05}t_{74} = -1.997$; $p = 0.05$
Weight	$_{0.05}t_{74} = 0.925$; $p = 0.358$
Height	$_{0.05}t_{74} = 1.168$; $p = 0.247$
Calcaneus-tibia angle, left	$_{0.05}t_{74} = -2.051$; $p = 0.044$*
Calcaneus-tibia angle, right	$_{0.05}t_{74} = -0.252$; $p = 0.802$
	Student's t test
Clarke angle, left	$_{0.05}t_{74} = -0.029$; $p = 0.977$
Clarke angle, right	$_{0.05}t_{74} = 0.094$; $p = 0.926$
Chippaux index, left	$_{0.05}t_{74} = -0.078$; $p = 0.938$
Chippaux index, right	$_{0.05}t_{74} = 0.459$; $p = 0.648$

* Difference statistically significant: $p < 0.05$.

Table 5.- Comparative analysis between players from the two sports clubs.

COMPARATIVE ANALYSIS BETWEEN PLAYERS FROM UD. SALAMANCA AND PLAYERS FROM UD. ST. MARTA	
VARIABLE	*Student's t test*
Age	$_{0.05}t_{91.874} = 0.028$; $p = 0.978$
Weight	$_{0.05}t_{98} = 0.385$; $p = 0.701$
Height	$_{0.05}t_{98} = 0.695$; $p = 0.489$
Years spent practicing sports	$_{0.05}t_{98} = -0.814$; $p = 0.417$
Calcaneus-tibia angle, left	$_{0.05}t_{98} = 2.494$; $p = 0.014$ *
Calcaneus-tibia angle, right	$_{0.05}t_{98} = 0.156$; $p = 0.384$
	Student's t test
Clarke angle, left	$_{0.05}t_{98} = -0.410$; $p = 0.683$
Clarke angle, right	$_{0.05}t_{98} = -0.722$; $p = 0.472$
Chippaux index, left	$_{0.05}t_{98} = -0.432$; $p = 0.667$
Chippaux index, right	$_{0.05}t_{98} = -0.413$; $p = 0.680$

* Difference statistically significant: $p < 0.05$.

relationship with its respective contralateral parameters ($_{0.01}r_{xy}$=0.729 for the Clarke angle and $_{0.01}r_{xy}$=0.782 for the Chippaux index). However, the correlation was negative, although not especially high, between both parameters of the same footprint ($_{0.01}r_{xy}$= - 0.581 between the left Chippaux index and Clarke angle and $_{0.01}r_{xy}$= - 0.560 between the same parameters for the right foot).

Regarding the correlation of the alignment of the hindfoot a positive linear relationship was found, although of low statistical intensity (${}_{0.01}r_{xy}=0.420$), between the *calcaneus-tibia angle* of both feet. This result confirms the general trend to valgus of the right hindfoot in comparison with the varus-trending left hindfeet of the total sample, already discussed in the descriptive analysis (Table 7).

Table 6.- Comparative analysis between juvenile and amateur players.

COMPARATIVE ANALYSIS BETWEEN JUVENILE AND AMATEUR PLAYERS	
VARIABLE	*Students' t test*
Age	${}_{0.05}t_{51.193} = -11.072$; $p < 0.001$ *
Weight	${}_{0.05}t_{98} = -2.061$; $p = 0.042$ *
Height	${}_{0.05}t_{98} = -2.204$; $p = 0.030$ *
Years spent practising sports	${}_{0.05}t_{61.401} = -6.739$; $p < 0.001$ *
Calcaneus-tibia angle, left	${}_{0.05}t_{98} = -0.098$; $p = 0.922$
Calcaneus-tibia angle, right	${}_{0.05}t_{64.029} = 0.697$; $p = 0.488$
	Student's t test
Clarke angle, left	${}_{0.05}t_{98} = 0.254$; $p = 0.800$
Clarke angle, right	${}_{0.05}t_{98} = 0.499$; $p = 0.619$
Chippaux index, left	${}_{0.05}t_{98} = 0.060$; $p = 0.952$
Chippaux index, right	${}_{0.05}t_{98} = 0.388$; $p = 0.699$

* Difference statistically significant: $p < 0.05$.

Table 7.- Analysis of bivariate correlations.

BIVARIATE CORRELATIONS		
VARIABLE		*Pearson R Test*
C-t angle, left	C-t angle, right.	${}_{0.01}r_{xy} = 0{,}420$
Clarke angle, left	Clarke angle, right	${}_{0.01}r_{xy} = 0{,}729$
Chippaux index, left	Chippaux index, right	${}_{0.01}r_{xy} = 0{,}782$
Chippaux index, left	Clarke angle, left	${}_{0.01}r_{xy} = -0.581$ *
Chippaux index, right	Clarke angle, right	${}_{0.01}r_{xy} = -0.560$ *

* Level of significance: $p = 0.01$.

Discussion

The development of the foot, together with the influence of certain sports in such development, remains obscure and the literature contains few references to these processes (Martínez, 2000). Nevertheless, different authors have related the practice of physical exercise and sports to structural alterations to the foot, and hence the footprint imprint, to acute and chronic lesions. In contrast, other authors have reported that a maximum overdemand would be necessary, such as that seen in gymnasts, who undergo long hours of training, for such alterations to arise (Viladot, 2002a; Viladot, 2002b).

In our study we found homogeneity in the sample in regard to the parameters measured on the footprint (*Clarke angle* and *Chippaux index*), a strong and positive correlation being observed in each of the parameters on considering both feet. However, these results, expressing a normal left foot and an intermediate right foot both in the players and in the non-players, differ from those reported by other authors (Sirgo, 1991; Velamazán et al., 2000.). On the other hand, Sainz de Baranda et al. (2001) concluded that 79.4% of professional players analysed show normal imprints (as compared with 14.1% with concave feet).

It would be appropriate to unify authors' criteria concerning the same parameters with a view to gaining greater reliability in the results, because since a negative correlation exists between the values of the Clarke angle and the Chippaux index as determined by the classifications of Bavor and Horawa and of Jawroski, the reference values of these authors are different from those provided by Martorell (1997) in regard to the Chippaux index.

It is striking that in the total sample, and by groups, a low correlation was found between the alignment of both calcaneus-tibia angles, with a general tendency towards valgus in the right hindfoot in comparison with a tendency to neutrality in the left foot.

Finally, it may be assumed that the juvenile players studied were very close to the end of their physical development or that this did not affect the parameters relative to foot statistics in any important way because these parameters proved to be very similar to those of the group of amateur players.

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