THE STUDY OF GAIT BIOMECHANICAL PARAMETERS IN ATHLETES

George IONESCU, Taina AVRAMESCU, Luminiţa BRABIESCU CĂLINESCU, Roxana DUMITRU

University of Craiova, Romania

Abstract: The aim of the study was to analyze the gait of athletes without traumatic lower limb pathology. The method of data collection used a system based on plantar pressure distribution platform Footscan Scientific Version, RSscan International. For each subject were made 5/3 consecutive measurements until movement has been achieved with a speed between 600-800 ms. The technique included the movement of the subject gait on a walking trail that includes the platform, with a total length of 6-9 m; pressure data are collected by a single contact of the foot with the platform. The tables made allowed the gait symmetry assessment by comparing the values recorded for the two plants. The symmetrical gait was present in 89% of subjects, and for the remaining 11% were recorded minor asymmetries (the comparative variability of parameters under 10%).
Keywords: *gait, athletes, assesment.*

Introduction

Due to the positive effects on physical and mental health, the intensive promotion of an active lifestyle, based on physical exercise brings about a potential increased risk of injuries due to sports practice at the level of performance or leisure. James and Jones [1] estimated a number of 26 injuries per 1,000 people in the US annually due to the practice of sports or recreational activities. Other studies attest that the practice of sports related injuries represent 10-19% of all acute injuries presenting to emergency services [2]. Therefore, sports injuries are a cause for concern both for athletes and for society. Knee, ankle and foot trauma are very common in sports. Running, jumping and maneuvering veering are associated with the most popular sports. Therefore it is not surprising that the majority of sports injuries involve the lower limbs. Sprained ankle is probably the most common injury in sport, with a rate of about 40% of all sports injuries, especially in football, basketball, volleyball, and handball. About 50% of all sports injuries are secondary to overuse. These injuries occur as a result of repeated micro traumatisms causing local tissue damage. The most common overuse injuries in athletes are achilles tendinopathy and medial tibial stress syndrome [3].

The main guidelines in the current sports bio research addresses the improvement, generation, standardization, acquisition and analysis of data obtained through non-invasive technologies. In the context of the present research we believe that these issues can be successfully applied in the prevention and / or monitoring the efficiency in sports traumatology recovery by using kinetic gait analysis techniques. In light of timely research the current topics interest falls within the scope of the proposed study domain, human gait from a modern perspective, addressing dynamically the biosystems involved.

In walking and running, the ground reaction force is acting on the foot, which is the only link between the body and the ground. Plantar pressure is the pressure field acting between the foot and the supporting surface during daily loco-motor activities. The ankle-foot complex forces are transmitted to leg and distal, the upper parts of the body. Consequently, the foot plays an important functional role in walking and running, and thus became an important topic of human locomotion biomechanics study. Despite the increased interest in the functions of the foot, the way these functions are performed during the stance phase and propulsion is not fully understood. However, because of the multifunctional and complex structures that make up the foot, the role of ankle-foot complex in the interaction of the leg with the ground during displacement is difficult to analyze [4].

The measurements of the planting pressure provide direct and objective information on how the various structures of the foot interact with the ground and offer a real opportunity to characterize the functional aspects of the ankle-foot complex during walking [5,6,7,8]. The pressure platform provide the specific location of the pressures as they arise under foot in dynamic gait, and the information obtained from such pressure measurements are important in gait and posture research, they diagnose problems with legs, in designing shoes for sport or various planting corrections, in the prevention of biomechanics sports injuries and in the objectification of the recovery process of sports injuries and other applications.

Material and Methods

Gait analysis was performed for each subject in the control group. The method of data collection used a system based on plantar pressure distribution platform Footscan Scientific Version, RSscan International, Olen, Belgium with a length of 0.5 m. In our study only dynamic measurements were conducted. The method used was the single or automatic step. In this method the procedure depends on the size of the platform that we use, ie for a platform with a length of 2 m we can register several steps during the same measurement. Because we used a platform of 0.5 m it was necessary to conduct several measurements for a bilateral analysis. The registration is for both plants, over 2 cycles of walking, paying attention to the alternative placement right / left leg. Please note that this type of measurement is allowed by the technical characteristics of the platform used, the software platform making the aggregation and presenting the information and comparison of images, of values for the two plants.

For each subject to be analyzed we recorded, with RSscan pressure platform, the following parameters:

• Maximum force - max F (N)
• Impulse - IN / cm)
• The rate of charge and load rate- LR (N / cm.s)
• CA Contact area- - contact area (cm2)
• The percentage of contact (%) of the active area during the support -% C
• Maximum pressure - Max P (N / cm2) and force applied to the sensor (max. F / peak area sensor)

The study of the ante-mentioned numerical parameters included recording, processing and analysis of an impressive volume of data. It totaled the 8ante-mentioned numerical parameters centralization of for each of the 10 anatomic areas analyzed of each leg and (20 items in total for each case). It centralized 90x20x8 (14,400 values) data series, for which the averages of standard deviation, maximum and minimum values, the coefficient of variation that allowed classification as a viable sample were calculated. For certain parameters which are made up of body weight (F Max and Max peak value in Area), the coefficient of variation was greater than 20% for most elements, which is logical. These parameters are useful in measuring the same patient data in different times and measurements.

After analyzing and centralizing these parameters we made tables with averages, minimum and maximum and biomechanical parameters for male and female subjects. We tried so as to identify gender differences and establish a set of reference data useful for comparing the values of pathology cases. The casuistry consisted of 50 male subjects, aged between 22-26.

Results

Table 1. The centralization of the biomechanical parameters investigated mean values for male subjects

	% Contact	Max F	Time Max F	The rate of charge	Impulse	Contact area	Active contact area	Max Value sensors
Left foot	%	N	ms	N/s	Ns	cm²	cm²	N
Toes	63.26	194.466	647.28	0.7642	41.988	20.544	20.544	7.382
Fingers 2-5	56.68	42.748	642.16	0.217	7.932	15.11	15.11	8.324
Meta 1	73.44	120.62	560.37	0.7124	61.638	12.896	12.896	4.738
Meta 2	77.8	201.222	601.13	0.6834	70.52	12.378	12.378	5.442

Meta 3	81.58	238.458	604.204	0.6812	72.682	10.202	10.202	6.168
Meta 4	82.92	203.438	560.184	0.5562	63.438	10.614	10.614	5.472
Meta 5	79.54	159.186	525.118	0.4976	46.658	14.912	14.912	6.75
medium foot	72.02	225.102	275.794	2.1494	66.498	46.248	46.248	10.002
Medium heel	57.3	340.574	163.1958	10.274	86.414	20.744	20.744	6.508
Lateral heel	57.38	276.708	163.426	10.7308	74.008	17.766	17.766	7.296
Right foot								
Toes	63.7	194.166	636.666	0.7754	41.672	21.36	21.36	7.88
Fingers 2-5	55.36	43.846	648.68	0.2514	7.89	14.476	14.476	7.536
Meta 1	75.92	136.59	591.028	0.7466	61.032	18.516	18.516	6.378
Meta 2	79.98	217.702	609.744	0.745	74.384	14.73	14.73	7.652
Meta 3	82.42	228.136	594.538	0.6992	71.522	11.612	11.612	7.434
Meta 4	82.6	191.616	536.612	0.5762	62.204	11.832	11.832	6.132
Meta 5	75.6	146.712	458.59	0.4502	45.65918	11.908	11.908	5.362
medium foot	69.2	214.388	254.604	2.2444	66.706	40.772	40.772	7.74
Medium heel	57.24	360.936	164.356	10.6718	92.23	21.282	21.282	7.678
Lateral heel	56.28	287.47	164.858	9.46	74.352	18.182	18.182	9.212

Table 2. The centralization of the biomechanical parameters investigated maximum values for male subjects

	% Contact	**Max F**	**Time Max F**	**Rată încărcare**	**Impuls**	**Arie de contact**	**Arie de contact activă**	**Valoare Max senzori**
Left foot	%	N	ms	N/s	Ns	cm²	cm²	N
Toes	89	239.7	696.7	1.11	51	23.8	23.8	10.5
Fingers 2-5	81	97.3	703.3	0.31	10.8	18.3	18.3	11.5
Meta 1	85	234	606.7	1.02	74.4	15.2	15.2	9.8
Meta 2	88	321.7	676.7	0.94	82.2	15.6	15.6	8.4
Meta 3	91	317.7	675.1	0.89	88.4	11.4	11.4	11.2
Meta 4	91	314.4	633.3	0.74	73.6	13.2	13.2	10.3
Meta 5	89	232.1	613.3	0.65	54.1	17.1	17.1	10.1
medium foot	87	369.3	320	2.92	79.1	54.6	54.6	14.4
Medium heel	71	426.6	192.9	12.47	102.4	24.8	24.8	12.5
Lateral heel	71	337.3	193.3	13.42	90.2	20.1	20.1	12.7
Right foot								

Toes	82	235.3	703.3	1.12	52.6	26.6	26.6	10.9
Fingers 2-5	80	96.3	706.7	0.33	9.5	17.6	17.6	11.7
Meta 1	90	225	663.3	1.01	74.6	21.8	21.8	10.2
Meta 2	91	315.3	662.1	1.03	81.8	16.3	16.3	10.2
Meta 3	93	312	653.3	0.87	86.1	13.9	13.9	12.8
Meta 4	92	250.7	623.2	0.71	73.12	14.2	14.2	9.2
Meta 5	89	231	543.3	0.57	53.8	14.5	14.5	9.8
medium foot	89	322.7	306.7	2.73	79.7	49.5	49.5	11.8
Medium heel	75	410.1	195.2	12.38	106.7	23.6	23.6	12.4
Lateral heel	73	335.6	197.1	11.37	91.5	19.6	19.6	12.9

We recall that in our study gait speed was constant within limits according to the developed analysis protocol of gait.

Table 3. From the analysis we note that for the male consignment the analysis of the coefficient of variation (CV) for the toe and both heel sides indicate limits for both plants. For the rest of the areas studied the group is heterogeneous.

Table 3. Parameters of the MaxF

Parameter	**Max F**				
	N				
Values	Mean	Deviation	Maximum	Minimum	CV
Left foot					
Toes	194.466	45.40411	239.7	123.5	0.233481
Fingers 2-5	42.748	19.25291	97.3	21.5	0.450382
Meta 1	120.62	48.57403	234	99.3	0.402703
Meta 2	201.222	63.0521	321.7	107.9	0.313346
Meta 3	238.458	70.233	317.7	149.1	0.29453
Meta 4	203.438	75.20472	314.4	139.4	0.369669
Meta 5	159.186	60.02479	232.1	59.9	0.377073
medium foot	225.102	99.79413	369.3	104.3	0.443328
Medium heel	340.574	68.22675	426.6	268.2	0.200329
Lateral heel	276.708	62.08996	337.3	185	0.224388
Right foot					
Toes	194.166	45.878	235.3	113.1	0.236282
Fingers 2-5	43.846	23.87439	96.3	31.9	0.544506
Meta 1	136.59	66.80952	225	107.6	0.489125
Meta 2	217.702	70.77842	315.3	107.9	0.325116
Meta 3	228.136	67.09096	312	103.3	0.294083
Meta 4	191.616	60.0134	250.7	131.1	0.313196
Meta 5	146.712	67.33786	231	77.5	0.45898
medium foot	214.388	80.98784	322.7	102	0.377763
Medium heel	360.936	72.53389	410.1	243.2	0.200961
Lateral heel	287.47	64.03364	335.6	185.6	0.222749

Discussion

By comparing the values recorded for the same parameter at the two plants we can appreciate the symmetry of gait. Going symmetrically was present in 89% of subjects, and for the remaining 11% were recorded minor asymmetries (comparative variability of parameters under 10%). In order to achieve a database of valid normative values, it is necessary to calculate the average, minimum and maximum for each parameter statistical distribution biomechanical investigation and its analysis by calculating the coefficient of variation. This allowed the identification and exclusion from the study those normative subjects who did not present any gait change in the observational analysis and were not aware of any structural, functional abnormalities or trauma (according to the anamnesis) but had values of parameters investigated with large deviation compared the corresponding values calculated for the age group.

The statistical distribution for each parameter and its analysis by calculating the coefficient of variation of biomechanical parameters that will permit the selection is included in normative database. They were considered as viable parameters, those parameters that were included in the homogeneous, relatively homogeneous and boundary samples.

For maximum force, the parameter values considered were those corresponding to the toe and the heel both sides, for both plants.

The need for plantar pressure measurement is the fact that the foot provides the primary area of interaction with the environment during locomotion. Thus, it is important to diagnose foot problems in an early stage to prevent injuries and risk management. A widely used method to evaluate the function of the foot is shown by the examination of the characteristics of the pressure planting. Pressure planting measurements provide an assessment of the foot and ankle functions during walking and other functional activities for the foot and ankle, that provide both support and flexibility needed to support the body weight and moving from one leg to another. Knowledge of these values is important for the evaluation of various foot diseases. In addition, planting pressure measurement systems offer a high degree of portability, allowing for its use in the recovery room or at the venue of sporting activities.

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