Changes in biomechanical parameters under the feet while maintaining balance in basketball players before and after training

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Abstract

Objective of the study was to determination of the nature of changes in the biomechanical parameters of the load under the foot and the postural status of basketball players under the influence of training.

Methods and structure of the study. The experiment involved 28 athletes from women's and men's basketball teams of the first division of the Republic of Serbia. On the podometric platform «RSscan» (500Hz), the subjects performed two modified Romberg tests with eyes open and eyes closed. The measurement was taken immediately before and after training. The parameters of the trajectory of the displacement of the center of pressure, the speed of movement of the center of pressure, the pressure values under the entire foot, as well as in the metatarsal and heel zones of both legs were recorded.

Results and conclusions. Despite the training, the pressure in the heel zone relative to the metatarsal zone remained 10% higher. After training, in both tests, the trajectory of the center of pressure movement in men significantly decreased. The difference between men and women affected only the speed of movement of the center of pressure in the metatarsal zone of the feet, recorded after training. Basketball players of both sexes are characterized by a shift in the center of pressure predominantly in the medial-lateral direction.

Keywords: *balance, foot zones, center of pressure, CoP, AP, ML.*

Introduction. Modern basketball is due to an ever-increasing range of dynamism and intensified load, placing increased demands on the psycho-physiological mechanisms of the body and the athletes musculoskeletal system. During the game, basketball players are forced to continuously move, stop quickly and suddenly, change the direction and speed of movement, perform jumps, throws, etc. from different positions, in interaction with and without an opponent. Their skills require high acceleration in the joints of the lower extremities, for sudden changes in direction of movement and landing during jumps, where the recuperative properties of the foot play a key role [1]. In addition, an important factor for the high-quality performance of technical and tactical actions in basketball is the athletes developed sense of balance. It is believed that a basketball player who rarely or never loses it, and one who quickly restores it when it is impaired, has good balance [2]. For this reason, in the training of basketball players, much attention is paid to exercises to develop a sense of balance, with special emphasis placed on training in conditions of dynamic play, and not just performing, even if specific to basketball players, jumping and running exercises [3].

Balance, or postural static control, can be defined as the ability to maintain a posture through an internal regulation mechanism of keeping the body in a stable and unchanged position, and the tendency to sway, or shift the center of gravity of the body, indicates a loss of proprioception in a person [4].

There are enough studies on the factors influencing the parameters of postural control, one of which is muscle fatigue [5, 6, etc.].

Objective of the study was to determination of the nature of changes in the biomechanical parameters of the load under the foot and the postural status of basketball players under the influence of training.

Methods and structure of the study. The experiment was carried out three days before an important match of the Serbian major league tour. The study involved 28 athletes from basketball teams of the first division of the Republic of Serbia: 14 men, 14 women, average age - 23 and 20 years, sports experience – 12,3 and 9,1 years, body weight – 93,5 kg and 69,5 kg , foot size – 47 and 41,5 (EU), respectively. To record the indicators, the podometric platform «RSscan International» (Belgium) was used, with resistant sensors located on a 128x64 matrix. Platform size 40x100 cm with operating frequency 500 Hz. The experiment included the use of two modified Romberg tests with eyes open (OE) and eyes closed (EC) for 100 s, according to the method [7]. Testing was carried out immediately before and after training. The training lasted 2 hours and included practicing technical and tactical actions. The parameters of the trajectory of the center of pressure (CoP) displacement, the speed of CoP movement, the pressure values under the entire foot, as well as in the metatarsal and heel zones of the right and left legs were recorded.

Results of the study and discussion. Table 1 presents the results of measurements in the Romberg tests with eyes open (OE) before and after training. The only indicator that was influenced by the training process was the magnitude of the CoP movement trajectory in men, which significantly decreased after training ($p<0,025$).

The same picture is observed in the eyes closed (EC) test ($p<0,031$) (Table 2). In women, a change in this parameter is also observed, but is characterized as a tendency to decrease ($p>0,05$).

From the point of view of gender differences, the analysis revealed a significant difference only in the repeated test with eyes closed in the rate of movement of the center of pressure in the metatarsal zone: in women it was greater (6,24±2,8 mm/s) than in men (4,24±1,1 mm/s) (F4,86 $p>0,039$).

Considering the nature of the load distribution under the feet, it was noted on average that there was a right-sided asymmetry and a greater load on the heel zone than in the metatarsal zone by 10%. But since these indicators have a high degree of variation, here we can only talk about a trend and a high degree of individualization of these values.

In any study, it is important to have criteria for assessing the results obtained. As a criterion, it is pro-

Table 1. Results of measurements in the test with eyes open, before and after training

Indicators	Foot	Women		Men	
		Before	After	Before	After
Metatarsus (%)	Left	14,5±9,3	20,1±11,1	19,2±10,6	16,2±7,0
	Right	21,0±9,0	24,6±11,0	26,3±9,8	25,1±7,5
Heels (%)	Left	32,0±16,4	28,2±12,7	26,6±9,8	29,1±6,9
	Right	32,5±12,1	27,1±9,6	27,9±9,6	29,6±8,7
Swing max travel CoP	dX [mm]	12,4±5,7	13,5±5,9	11,9±5,9	12,2±4,5
	dY[mm]	23,1±16	26,8±13,9	24,9±7,2	24,3±10,3
Trajectory	CoP [mm]	485,3±124,5	474,2±132,6	*545,4±86,3	*474,6±71,1

**statistically significant results p<0,025.*

Table 2. Results of measurements in the test with eyes closed, before and after training

Indicators	Foot	Women		Men	
		Before	After	Before	After
Metatarsus (%)	Left	15,4±10,7	17,2±10,2	18,4±10,0	16,6±7,0
	Right	23,3±12,4	23,2±11,4	26,6±7,7	25,3±6,6
Heels (%)	Left	27,4±11,2	29,3±11,8	27,2±10,1	29,2±6,5
	Right	33,9±12,8	30,3±11,1	27,8±9,1	28,9±7,8
Maximum movement	dX [mm]	15,3±5,8	13,7±6,1	15,4±7,2	12,6±6,1
	dY[mm]	31,6±18,7	33,1±14,6	27,7±9,6	30,2±13,1
Trajectory	CoP [mm]	662,4±229,3	615,9±182,8	*728,9±116,4	*623,0±130,4

**statistically significant results p<0,031.*

Table 3. Comparison of the obtained values in the study [14] with our own results

Indicators		OE	EC	EC	EC	EC / OE	EC /OE	OE	EC
		Before	After	Before	After	Before	After	After/ Before	After/ Before
Results from the study [18]									
CoP mm	L	254,7	368,8	281,5	363,4	1,11	0,99*	1,45	1,29
CoP speed, mm/s	AP	5,2	10,6	5,8	8,1	1,12	0,76*	2,04	1,40
	ML	5,9	8	6,3	8,4	1,07	1,05	1,36	1,33
Maximum movement, mm	AP	10,2	23	12,5	23,7	1,23	1,03	2,25	1,90
	ML	11,2	16,4	10,6	19,7	0,95*	1,20	1,46	1,86
Results of our own research									
CoP mm	L	478	464,7	631,8	583,2	1,32	1,26	0,97*	0,92*
CoP speed, mm/s	AP	2,82	3,07	4	3,79	1,41	1,23	1,09	0,94*
	ML	4,08	3,87	4,63	4,10	1,13	1,06	0,94*	0,88*
Maximum movement, mm	AP	11,8	13,3	14,8	13,9	1,25	1,05	1,13	0,94**
	ML	21,8	27	32,3	33,7	1,48	1,25	1,24	1,04**

Difference: according to the proposed standards of trajectory and speed***

posed to calculate the CoP trajectory coefficient through the ratio of its values – «after training/before training». The required range of the coefficient is also indicated - from 1,2 to 2 units [8-11]. In our case, the values of the trajectory ratio coefficient are less than the proposed limits. In table For comparison, Figure 3 presents the results of a study on football players aged 14,5±0,2 years, using measuring equipment similar to ours, performing the Romberg test on it for 30 s [11], which explains the difference in the lengths of the trajectories.

Similar to the approach to estimating the trajectory length, a criterion is proposed for the speed of CoP movement. The recommended value is between 1,22 and 3,73 [11]. In our study, the speed of CoP movement, as well as in relation to the trajectory, is below the specified range. The reason for the differences in results, apparently, must be sought in the specifics of the sport and the stage of preparation. Nevertheless, this approach to assessing balance ability is of interest and has grounds for further development. Table 3 presents the results of the ratio of the indicators of the EC/OG tests as the influence of the factor of visual perception.

The result of the formed dynamic stereotypes is also indicated by the predominance of the direction of movement of the center of pressure. In football players, the shift in the center of pressure occurs predominantly in the AR direction. In basketball players, the center of pressure shifts more in the ML direction, as other authors point out in their works [12]. In this case, the speed of CoP movement in the AP direction is lower than the speed in the ML direction.

The experiment confirmed the statement of many authors about the increase in the area of contact of the foot with the support as a result of a vertical shock load (walking, running, jumping) [13]. All subjects observed an increase in the area of contact with the support after the training.

Conclusions. After training, the trajectory of the CoP center of pressure movement in men both in the balance test with open and closed eyes decreased significantly. Significant differences between men and women affected only the rate of movement of the center of pressure in the metatarsal zone of the feet, recorded after training. Basketball players of both sexes are characterized by a shift in the center of pressure predominantly in the medial-lateral direction. The contact area of the foot with the support increases after training load.

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