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Original Article

Determination of balance parameters as physical training factors in Athletics

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Abstract:
The interest in achieving sports performance in the shortest possible time, with increased efficiency and minimal biological risk has led to a huge development of scientific research in the field of sport, but also to a greater receptivity to the transfer of knowledge and applications in other fields (Gagea , 2007, p. 7).

Proprioception is innate "talent" of body awareness and knowledge if the body is positioned in space. This feeling is closely related to the sense of muscle tone and effort and balance perceptions (Ljubojević, A., s.c., 2012, pp. 257-266). Proprioception was defined as the ability to integrate sensory signals from different mechanoceptors to determine the position of the body and space movements (Han, 2015, pp. 1-11, Goble, 2010, pp. 1176-1184) and plays a crucial role in controlling the balance (Röijezon, 2015, pp. 368-377, Pasma, et al., 2012, pp. 1138-1148, Clark, et al., 2015, pp. 378-387). Theoretically, proprioceptive information from every part of the body contributes to balance control. The purpose of the research is to analyze the balance, proprioceptionand attic mobility of one of the best Romanian athletes in sprint (100m and 200m) and long jump.

The research is a case study for which we used a complex modern logistics: the Sensamove balance platform and the biomechanical analysis system of the "Opto Jump Next" movement, equipped by the laboratory of the Center for Research on Human Permanence at the University of Pitesti.
Key words: Athletics,motor control, proprioception.

Introduction

The interest in achieving sports performance in the shortest possible time, with increased efficiency and minimal biological risk has led to a huge development of scientific research in the field of sport, but also to a greater receptivity to the transfer of knowledge and applications in other fields (Gagea , A., 2007, p. 7).

Acsinte, A., (2011, pp. 116-120) defines proprioception as "the body's ability to obtain information for the brain in response to a stimulus that occurs in the body; also refers to "the body's ability to sense the position of its limbs at any time. Balance derives from sensory nerve endings in the muscles and wrists, called proprioceptors. By developing the balance, the body becomes more agile in movement, decreases the risk of injuries and develops a number of abilities such as running and jumping. Proprioception is innate "talent" of body awareness and knowledge if the body is positioned in space. This feeling is closely related to the sense of muscle tone and effort and balance perceptions (Ljubojević, A., s.c., 2012, pp. 257-266). Proprioception was defined as the ability to integrate sensory signals from different mechanoceptors to determine the position of the body and space movements (Han, J., s., 2015, pp. 1-11, Goble, DJ, 2010 , pp. 1176-1184) and plays a crucial role in controlling the balance (Röijezon, U., s.c., 2015, pp. 368-377, Pasma, JH, et al., 2012, pp. 1138-1148 Clark, NC, et al., 2015, pp. 378-387). Theoretically, proprioceptive information from every part of the body contributes to balance control.

The research aims an investigation of static and dynamic balance and proprioception concerning unipodal and bipodal support as well as the mobility of the ankle joint.

Material and methods

In our research we used a modern and complex measurement logistics that is part of the laboratory of the Research Center for Human Performance, University of Pitesti. The device used (the Sensamove balance platform, Opto Jump Next) is based on innovative, non-invasive technology that allows real-time data recording and offers the possibility of storing them in the form of Notepad data files, Excel and in the form of graphical files. The aforementioned measuring apparatus allowed us to perform tests that looked at: static and dynamic balance (bipodal and unipodal) and ankle joint mobility. The choice of tests was done in accordance with the particularities of the sports samples and branches practiced by the subject, the test battery structure being the following: Static balance test; Proprioception balance test; Dynamic horizontal balance test; Dynamic vertical balance test; March in place open eyes; March in place closed eyes;

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The main methods used in the paper were the bibliographic study method, the test method, the data recording method, the graphical and tabular method and the statistical mathematical method.

Results

Static balance testing was done using the Sensamove platform. The tests concerned: static balance (table 1), proprioception (Table 2) and dynamic balance (Tables 3 and 4), the latter being measured horizontally (left-right) and pevertical (forward and backward). graphical form (Figures 1-4) and numerical (Tables 1-4), the values revealing performance levels expressed as a percentage (%) and mean values of the four-way oscillations (left-right) in degrees (0)

Table 1 Static balance test

Bipodal		**Unipodal dr.**		**Unipodal stg.**	
Performance	87	Performance	87	Performance	89
Front avg deviation	0,92	Front avg deviation	0,91	Front avg deviation	0,68
Back avg deviation	1,00	Back avg deviation	0,69	Back avg deviation	0,94
Left avg deviation	0,82	Left avg deviation	0,56	Left avg deviation	0,72
Right avg deviation	0,57	Right avg deviation	0,88	Right avg deviation	0,52

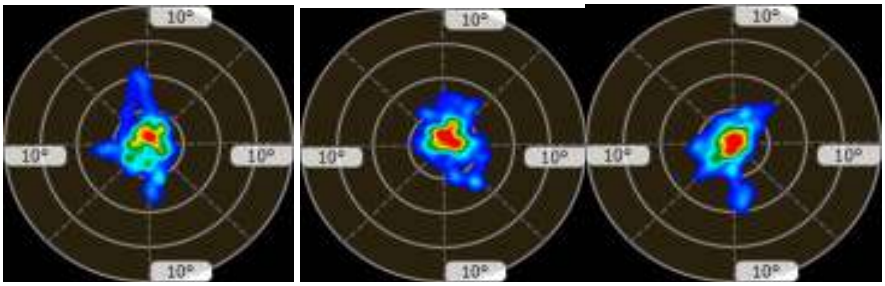

Fig. 1. Static balance test

Regarding static bipolar balance, the subject achieved a performance score of 87%, which can be appreciated as a good result, and can be assigned the grade well. Static unipodal balance measurements in the right leg have a 87% score, a good score, and a 89% better score on the left leg may be due to the fact that the left foot is the long leg jump.

Table 2. Balance test proprioception

Bipodal		**Unipodal dr.**		**Unipodal stg.**	
Performance	86	Performance	75	Performance	82
Front avg deviation	0,98	Front avg deviation	2,27	Front avg deviation	1,54
Back avg deviation	0,68	Back avg deviation	0,30	Back avg deviation	0,62
Left avg deviation	0,51	Left avg deviation	1,03	Left avg deviation	0,72
Right avg deviation	0,99	Right avg deviation	0,38	Right avg deviation	1,19

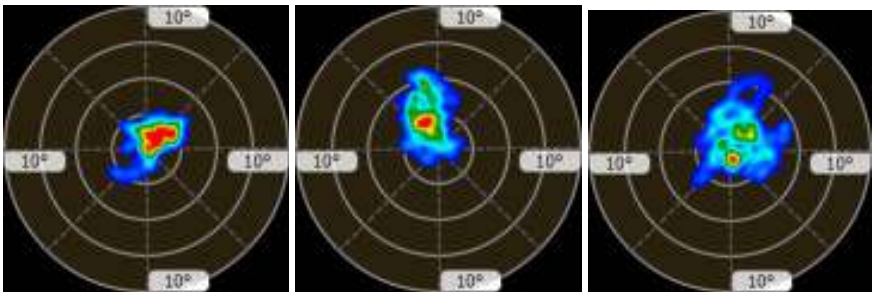

Fig. 2. Proprioception balance test

As far as proprioception is concerned, the athlete achieves a good score at the bipodal balance (86%) close to the static test score, but a lower score at the unipodal balance, especially at the right foot (75%) with a tendency to incline towards forward and left. On the right foot, the score is 82%, with a tendency to tilt forward and right.

Table 3. Left – right (horizontal) dinamic

Bipodal		**Unipodal dr.**		**Unipodal stg.**	
Performance	76	Performance	58	Performance	62
Front inside	28	Front inside	35	Front inside	38
Back inside	48	Back inside	23	Back inside	25
Front avg deviation	1,45	Front avg deviation	1,69	Front avg deviation	1,79
Back avg deviation	-1,43	Back avg deviation	-2,28	Back avg deviation	-2,06
Left avg deviation	-4,20	Left avg deviation	-3,63	Left avg deviation	-4,57
Right avg deviation	5,03	Right avg deviation	4,66	Right avg deviation	3,34

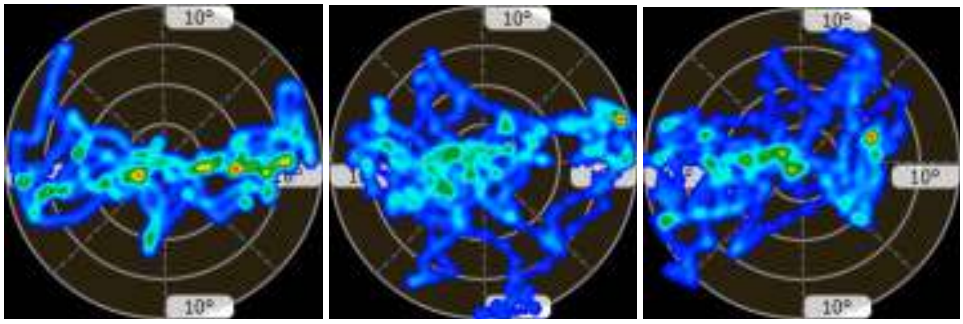

Fig. 3. Left – right horizontal dynamic balance

Table 4 Front - back (vertical) dynamic

Bipodal		**Unipodal dr.**		**Unipodal stg.**	
Performance	94	Performance	78	Performance	93
Front inside	47	Front inside	38	Front inside	45
Back inside	47	Back inside	41	Back inside	48
Front avg deviation	4,43	Front avg deviation	5,52	Front avg deviation	5,14
Back avg deviation	-4,67	Back avg deviation	-5,52	Back avg deviation	-3,99
Left avg deviation	-0,82	Left avg deviation	-1,14	Left avg deviation	-0,86
Right avg deviation	0,91	Right avg deviation	1,32	Right avg deviation	0,78

Fig. 4. Front – back vertical dynamic balance

Tests for mobility (dynamic balance) showed 94% (bipodal) and 93% (unipodal left) in the antero-posterior plane, corresponding to the very well standardand a score of 78% (unipodal right) corresponding to a good standard. As for the degree of sagittal mobility (left-right), the values are weaker especially for the unipodal right foot test with a 58% score.

Measurement of the dynamic balance with the Opto Jump Next without feed-back (table 5) and feed-back (table 06) allowed us to record the following parameters: ground contact time, flight time (air), rhythm / cadence , the lateral displacement relative to the starting position of the test (negative values indicating a shift to the right, while the positive values signify a left shift), the lateral movement of the legs from one repetition to the other (the negative values indicating a shift to the right, while positive values signify a shift to the left), the distance between alternate contacts. Due to the large amount of data, we have decided to present only the minimum, maximum, arithmetic and standard deviations for each measured parameter.

Table 5. March in place open eyes 15 sec

	TCont. L[s]	TCont. R[s]	TFlight L[s]	TFlight R[s]	Pace L[step/m]	Pace R[step/m]	Pace L[cycles/s]	Pace R[cycles/s]	Cycle L[s]	Cycle R[s]	Jumping Point L[cm]	Jumping Point R[cm]	Tendency L[cm]	Tendency R[cm]	Used Area L[cm]	Used Area R[cm]
Mini mum	0,143	0,145	0,311	0,17	202,36	213,14	1,69	1,78	0,48	0,48	-2,6	-3,7	-2,6	-2,1	11,4	12,5
Maxi mum	0,171	0,183	0,41	0,392	248,45	258,62	2,07	2,16	0,581	0,557	7,8	7,3	3,6	3,2	19,8	20,8
Avg	0,151	0,153	0,348	0,342	240,09	240,69	2	2,01	0,5	0,501	2,3	2,2	0,1	0,1	16,3	16,5
Std dev	0,007	0,009	0,017	0,036	8,83	9,95	0,07	0,08	0,02	0,019	2,7	2,7	1,7	1,4	2,4	2,2
CV	4,6	5,9	4,9	10,5	3,7	4,1	3,5	4	4	3,8	117,4	122,7	1700	1400	14,7	13,3

Table 6. March in place eyes closed 15 sec

	L[s]	R[s]	L[s]	R[s]	p/m]	p/m]	s]	s]	L[s]	R[s]	m]	m]	m]	m]	m]	m]
Mini mum	0,158	0,164	0,28	0,133	31,31	145,63	0,26	1,21	0,53	0,518	-37,4	-33,3	-10,9	-9,9	1	2,1
Maxi mu	0,282	1,778	2,055	0,542	228,14	230,33	1,9	1,92	2,238	2,32	3,2	1	10,9	5,7	30,2	26
Avg	0,176	0,24	0,435	0,364	212,05	220,23	1,77	1,84	0,617	0,616	-14	-14,3	-0,1	-0,9	16,8	16,1
Std dev	0,024	0,321	0,338	0,06	38,76	16,54	0,32	0,14	0,346	0,363	10	10,4	4,6	4,2	6,1	5,9
CV	13,6	133,8	77,7	16,5	18,3	7,5	18,1	7,6	56,1	58,9	-71,4	-72,7	-4600	-466,7	36,3	36,6

Regarding static bipolar balance, the subject achieved a 87% performance score that can be judged to be a good result, with the grade being well attributed, with a slight inclination to the left. As for pro-rhythm, the subject achieves a performance score of 86% (good), very close to the score obtained in the normal static test. It shows a slight tendency to incline to the left and inward. As for dynamic balance in a horizontal sense, with a 76% performance score, the data means a less good capacity, the dynamic balance being better on the right side. Regarding the dynamic balance in the vertical sense, the achieved performance score was 94%, which shows a very good balance capacity with a high degree of mobility both on flexion and on extension.

Measurements related to the unipodal balance in the right leg can highlight the following considerations: the static balance capacity reveals a performance score of 87%, which may be similar to the good rating, with a slight tendency to incline right to forward. proprioceptive data, they show a 75% performance score with a fairly large slope to the left; Dynamic Balance Capability has a more efficient trend in vertical balance with a performance score of 78%, with an anterior-posterior motion superior to the sagittal plane (58% performance score)

Tests that focused on left-handed unipodal balance showed a better static balance capacity (89% performance score) compared to the one recorded by the right foot, with a tendency to tilt left and back. Proprioception presented a score of 82%, with lateral differences to the right and to the anterior-posterior, forward. As for the degree of mobility (dynamic balance), the data signify a low mobility in the sagittal plane (with greater amplitude towards the part left) with a performance score of 62%, while in the anterior-posterior plane the movement is very well controlled with a performance score of 93%.

Dynamic specific balance measured through the open eyes and closed eyes test - shows good values both in terms of using external feedback and in terms of using intrinsic feedback.

Conclusion

The tested athlete has a good and very good level of the static balance of proprioception and dynamic balance due to the fact that he uses means to improve them in the training sessions. Considering that it is a national champion in the 100m, 200m and long jump, the results recorded by him can be the benchmarks in the training of the practicing athletes.

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