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The Proprioceptive Training in the Preparation of Handball Players

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Abstract

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With an important role in normal human performance, proprioception also has a significant impact on the performances of the sports activity. The current trend in modern handball is increasingly resorting to training methods that use proprioceptive structures in the handball players' preparation. The purpose of this study was the elaboration and experimental implementation of a training program comprising means of a proprioceptive character, oriented in order to optimize the preparation of the handball players' in view of of maximally using their performance capacity. The hypothesis of this study is that by using the means of a proprioceptive nature we can find the proprioceptive correlation between the results of tests applied and the technical parameters of the offensive game of handball in official games. Methods: The research involved a total of 20 junior II sportwomen, equally divided into two groups: the experimental group and the control group. During the experiment a training program was implemented comprising means of a proprioceptive nature and eight tests were applied. Results: Following the study conducted on the correlation between test results of control tests and parameters of the game of handball we can say that there are statistically significant correlations at a significance threshold of $p < 0.01$, between the tests applied and certain parameters of the game, such as: Total Goals marked, goals scored from 7m, goals scored on the counter-attack, goals scored from the extreme and goals scored from 6m, which confirms the working hypothesis.

Keywords: training; proprioception; preparation; competition; results; athletic edge.

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1. Introduction

Handball is one of the games that have special physical requirements, such as: power, speed, agility, resistance, balance, flexibility, precision and coordination that, in turn, lead to an obvious, significant effect, on the physical performance and promote physical and functional efficiency for the players handball and therefore affect performance, skills development and mastery of the game performance (Badr, 2013). The handball players' activity is based on general motor skills, to facilitate the acquisition of knowledge in specific technical and situational tactical elements, all critical to achieving success in sport (Bojić & Pavlović, 2014).

The current trend in modern handball is increasingly resorting to training methods that use proprioceptive structures in the preparation of handball players. Acsinte (2011) defines proprioception as "the body's ability to get information to the brain, in response to a stimulus that occurs in the body"; moreover, it refers to "the body's ability to sense the position of its limbs at any time." Proprioception includes a sensory system that allows people to detect not only the position and movement of limbs, but also the force generation feeling. With an important role in normal human performance, proprioception also has a significant impact on the performances from the sports activity. Proprioception is the body's ability to convey the sense of position, to analyse this information and react (consciously or unconsciously) to stimuli, with the corresponding movement (Kumar, 2014).

Proprioceptive exercises provide training for the brain, nerves and muscles to communicate as accurately as possible where the body is located and how it is moving (Gorostiaga, et. al., 2006). In the field of sports training, neuromuscular training programs that include balance exercises are often implemented, in order to optimize performance, accident prevention, or recovery from injury. It seems that these exercises have an influence on neuromuscular control and functional performances (Zoltan, 2004, pp. 139-172).

Studies conducted have proved that using specific exercises in order to develop these indicators, by using certain helpful tools, can result in increased performances and motor skills specific to the handball game.

One of the current trends is incorporating into training programs of specific elements of proprioception training, designed to improve specific indicators of static and dynamic balance, as well as neuro-muscular coordination, starting at an early age (Acsinte et. al., 2012). Programs for the development of neuromuscular control, often include balance exercises in order to optimize the preparation, prevention or recovery following injuries (Zech et. al., 2010). Some researches show that the most efficient sportsmen are those who manage to control the body and body segments, in the best conditions of coordination (Acsinte et. al., 2012). If similar programs of neuromuscular training had been initiated complete, spread on a large scale, the handball players could reach optimum levels of performance, by the combinatorial effects of improving power, force, speed, stability of the pelvic area, functional biomechanics and injury risk reduction. In addition, if used at the right time in the development of muscle and movement control, even greater effects could be achieved both in terms of performance and in decreasing the risk of injury (Myer et. al., 2005). Poor performance is due to lack of neuromuscular stabilization which has the effect of changing length-tension, force-couple relations, as well as of joint kinematics.

All these exercises (proprioception stimulation under special circumstances, on mobile areas, balance fit, Wobble board, Balance Board, etc.) performed in a certain way (with the eyes closed), can contribute to enhancing the quality of athletic performances, especially in game situations with a great psychological stress, as well as in situations of performantial technical demands of body in unnatural positions (imbalances in the air, passes, throws, etc.) (Acsinte, 2004; Acsinte & Eftene, 2007). Proprioceptive trainings have been proven to be particularly beneficial for improving the dynamic stability of the joints. At a high level, handball players have a vast technical repertoire that is supported by skills, such as coordination, balance, agility, as well as speed of reaction and execution (Starosta, 2006).

1.1 Hypothesis

The hypothesis of this study was that proprioceptive training would have positive effects on the handball players' offensive game.

1.2 Materials and methods

Period and location of the research

This research was conducted during the 2013-2014 competitive season, comprising two groups: experimental and control. The handball players included in the experimental group belonged to the Arena Sports Club Târgu Mureş, and the handball players included in the control group belonged to the Sports Association of "Ioan Vlăduţiu" School Ludus.

Research subjects

Twenty subjects participated in this study (20 adolescent females, 15-16 years of age). They were equally distributed into two groups: the experimental group and the control group. The participants were players operating on the extreme and pivot positions. The experimental protocol was explained to participants and written informed consent was obtained from them. Research protocol was approved by the Ethics Committee of the Faculty of Physical Education and Sport, Babeş-Bolyai University of Cluj-Napoca.

The two groups trained five times a week for an hour and a half, according to the training plan established by the two teacher coaches, using means specific to handball game training. Unlike the control group on the experimental group, within individualized training, three times a week, for 30 minutes, was acted upon with means of a proprioceptive nature proposed by us: exercises performed on unstable surfaces (balance fits), with elastic bands, with TRX.

Tests applied

The battery of tests was selected from the author's paper (Reiman & Manske, 2009). Moreover, the testing of subjects of the two groups was performed on force platform AMTI BP400600.

By means of these tests it were aimed the assessing of the level of certain indicators: speed, agility, multidirectional body control, control on body posture and balance.

During the research the following statistical-mathematics indices were used: arithmetic mean average, standard deviation, amplitude, variation quotient, effect size, Wilcoxon test, Mann-Whitney test, correlation. The data for each topic were introduced in the database, the statistical analysis relating to statistical indicators and verifying statistical hypotheses (statistical inference) were performed with

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SPSS 20 specific for the statistical analysis of data from the field of social sciences (Statistical Package for the Social Sciences).

1.3 Results

The stability test with multiple jumps on the right leg revealed a mean value of the score for execution errors lower than in the experimental group with 29.90 (58.5%) points. Mean averages are equal to 21.20 in the experiment group, with 51.10 points in the control one, respectively. In both groups the data dispersion is non-homogeneous (**Table 1**).

Table 1. Comparative statistical analysis of the experimental group vs the control group the stability test with multiple jumps on the right leg

Groups	Mean average	Average differences	Median	Minimum	Maximum	Variation Quotient	Mann-Whitney		Effect size
							Z	P	
Experiment	21.20	-29.90	20.50	6	36	53.1%	-3.100	0.002	0.69
Control	51.10	58.5%	52.00	21	73	38.6%			

The difference is statistically significant according to Mann-Whitney test of significance, for z = -3.100 and p = 0.002 <0.05. The effect size (0.69) shows a big to very great difference between the two final tests.

In the stability test with multiple jumps on the left leg it was emphasized an average score corresponding to the corresponding committed by subjects lower than in the experiment group with 26.40 (52.8%) points. Mean averages are equal to 23.60 in the experimental group, with 50.00 points in the control one, respectively. Data dispersion is uneven in both groups (**Table 2**).

Table 2. Comparative statistical analysis in the experimental group vs the control group the stability test with multiple jumps on the left leg

Groups	Mean average	Average differences	Median	Minimum	Maximum	Variation Quotient	Mann-Whitney		Effect size
							Z	P	
Experiment	23.60	-26.40	22.0	6	43	55.8%	-2.879	0.004	0.64
Control	50.00	52.8%	42.0	28	79	35.9%			

The difference is statistically significant according to Mann-Whitney test of significance, for z = -2.879 and p = 0.004 <0.05. The effect size (0.64) shows a big to very high difference between the two groups.

Upon testing of the bipod balance with the feet together, the eyes open it was found a mean average value of the distance of travel along the X axis lower in experiment group with 0.065 (20.5%) cm. This difference indicates an increase in static equilibrium in the experimental group. Mean averages are equal to 0.254 in the experimental group, 0.319 cm in the control, respectively. Data dispersion is inhomogenous in the experiment group and homogeneous in the control one (**Table 3**)

Table 3. Comparative statistical analysis of the experimental group vs the control group in bipod balance with feet together, eyes open

Groups	Mean average	Average differences	Medi-an	Mi-nimum	Ma-ximum	Variation Quotient	Mann-Whitney		Effect size
							Z	P	
Experiment	0.254	-0.065	0.227	0.172	0.419	35.0%	-2.268	0.023	0.51
Control	0.319	20.5%	0.321	0.274	0.379	10.8%			

The difference is statistically significant according to Mann-Whitney test of significance, for z = -2.268, p = 0.023 <0.05. The index of effect size (0.51) shows a big to very high difference between the two groups.

In agility test "Illinois" to assess the speed, agility and multidirectional body control was found (**Table 4**) an average execution time lower in the experimental group with 3.33 (17.2%) seconds. Mean averages are equal to 15.99 in the experiment group, with 19.32 seconds in the control, respectively. **Data dispersion is homogeneous in both groups.**

Table 4. Comparative statistical analysis of experimental group vs control group "Illinois" agility test

Groups	Mean average	Average differences	Medi-an	Mi-nimum	Ma-ximum	VariationQuotient	Mann-Whitney		Effect size
							Z	P	
Experiment	15.99	-3.33	16.00	15.2	16.7	3.2%	-3.785	<0.01	0.85
Control	19.32	17.2%	19.20	18.0	20.7	4.5%			

Mann-Whitney test of significance indicates a statistically significant difference for z = -3.785 and p <0.01 <0.05. The effect size (0.85) indicates a very high difference between the two tests.

Table 5. Correlations between the results of the control tests and the parameters from the handball game in the experimental group – the far left

CONTROL TESTS		**GAME PARAMETRES**					
		Throws to the gate	Total goals marked	**Goals scored**			
				From 7m	From the extreme	On counter-atack	From 6m
Multiple jumps on the right leg	r	0.321	0.173	0.012	-0.090	0.277	0.274
	p	0.365	0.632	0.973	0.805	0.439	0.444
Multiple jumps on the left leg	r	**-.828****	**-.868****	**-.918****	-0.108	**-.767****	-0.363
	p	***0.003***	***0.001***	***0.000***	0.767	0.010	0.302
Bipodal balance with open eyes	r	-0.257	-0.416	-0.396	**-.749***	-0.221	0.418
	p	0.473	0.232	0.258	***0.013***	0.540	0.229

We note that there are statistically significant correlations at a significance threshold of p <0.01 between multiple left leg jumps and the game parameters: total goals marked, goals scored from 7m, goals scored on the counterattack.

The correlations are negative as the decrease in the number of points due to a decrease in execution errors at multiple left leg jumps involves the improvement of the game parameters listed above.

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Moreover, *bipod balance with eyes open* is correlated negatively and statistically significantly, at a significance threshold equal to 0.01. Decreasing movement increases static balance which positively influences the parameter of *goals scored from the extreme*.

There are also correlations with coefficients that have appreciable value, positive or negative, but not statistically significant.

Table 6. Correlations between the results of the control tests and parameters from the handball game in the experimental group – the far right

CONTROL TESTS		GAME PARAMETRES				
		Throws to the gate	Total goals marked	Goals scored		
				From the extreme	On counter-atack	From 6m
„Illinois" agility test	r	**.882****	0.604	**.637***	-0.098	**0.714***
	p	***0.001***	*0.064*	***0.048***	*0.787*	***0.02***

To the far right there are statistically significant correlations at a significance threshold of $p < 0.01$ between the results of *"Illinois" agility test and shots on goal*. There are also statistically significant correlations between the results of *"Illinois" agility test* and game parameters *goals scored from the extreme and goals scored from 6m*, but at a significance threshold of $p < 0.05$.

The correlations are positive, as decreasing time increases speed, agility and multidirectional body control which correlates with an increase in the value of game parameters stated above.

Also on the far right there are correlations whose coefficients have appreciable values, positive or negative, but not statistically significant.

Table 7. Correlations between the results of the control tests and parameters from the handball game in the experimental group – pivot

CONTROL TESTS		GAME PARAMETRES			
		Throws to the gate	Total goals marked	Goals scored	
				On counter-atack	From 6m
Multiple jumps on the right leg	r	**-.755***	-0.575	**-.820****	-0.297
	p	***0.012***	0.082	***0.004***	0.404

For the post of pivot there are statistically significant correlations at a significance threshold of $p < 0.01$, between the results of test of *multiple jumps results on the right foot and goals scored on the counterattack.* There are statistically significant correlations but at a significance threshold of $p < 0.05$ between the results from *multiple jumps on the right leg and throws at the gate* and also between the results of the *test with "three cones"* and the game parameter *throws at the gate*.

The correlations are negative between measured values at test *multiple jumps on the right leg* and the two parameters of the game as decreasing the number of points due to decreasing errors of execution at multiple jumps on the right foot increases the parameter values *shots on goal* and to the increase in the number of goal scored on counterattack.

2. Discussion and Conclusions

There are a small number of studies regarding the proprioceptive approach to the optimization of athletic performance. The situation changes when it comes to prevention or post-traumatic rehabilitation using proprioception methods. The role of proprioceptive training is highlighted in a series of studies conducted in different sports. In a study conducted on basketball players, Sevreza & Bourdin (2015) have found that success in free throws is, at least partly determined by the capacity of players to feel the position of the distal joints based on the proprioceptive impulses related to the wrist. Westin, Hermeto and Noyes (2015) found, in a study realized on junior tennis players, that after applying a neuromuscular and performance program of six weeks, the players improved their speed, agility, dynamic balance and resistance of the muscles of the pelvic area. The importance of different means of a proprioceptive nature (active repositioning of the joint, the sense of strength, coordination, muscular strength, balance on unstable surfaces, plyometry, etc.) to improve the proprioceptive sense on the long term was highlighted in a study realized by Roijezon, Clark & Treleaven (2015).

The purpose of this study was to investigate whether proprioceptive training could improve the parameters which quantify the official handball games' results. According to the above presented findings, proprioceptive training may have beneficial effects on the athletic performance of junior handball players during official games. Aman et al. conclude in (2015) that proprioceptive training can produce significant improvements in motor function. Taking into consideration the fact that there is a relationship between motor skills and social communicative skills, but it is still not known how exactly improved motor function influences social communication, one could summarize that more research is needed on the impact of proprioceptive training on athletic performance and on social communication.

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