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INFLUENCE OF COMPLEX TRAINING ON EXPLOSIVE POWER OF KNEE EXTENSOR MUSCLES OF BASKETBALL JUNIORS

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Abstract

The aim of this paper is to establish the effects of an experimental treatment, so called "Russian complex" on explosive leg power of the basketball players belonging to the experimental group. Explosive leg power was measured on the sample consisting of 40 basketball players from the Serbian league: 20 basketball players from the experimental group and 20 from the control group, all aged between 16 and 18. The experimental group was the subject of the experimental treatment, so called "Russian complex", which included gym exercises and took place twice a week during the period of ten weeks. The results of the univariate analysis of covariance indicated that the experimental programme led to a statistically significant improvement of all three motor variables used for the evaluation of explosive leg power (Sargent Jump Test, Standing Triple Jump and Standing Jump) in the experimental group of examinees, in comparison to the control group.

Keywords: Russian complex, explosive leg power, training effects, basketball players.

Introduction

The complex training of basketball players was established by Russian and Bulgarian coaches and it included a combination of more and less demanding exercises during one training (Ebben, & Blackard, 1998). In science and sport that type of exchanging maximum and explosive muscle contractions of the same (agonistic) muscle group is known as a "complex training". There is an opinion among coaches that overcoming difficulties caused by loading a body (e.g. by weights), as well as dealing with small loading (e.g. body weight) produces a better neuromuscular adaptation (Sale, 2002).

This complex type of training causes a better neuromuscular adaptation and the maximum force and speed of using that force, so the combination of concentric, exentric-

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concentric explosive exercises influences a quick generating of muscular force (Adams, O'Shea, O'Shea, & Climstein, 1992; Burger, Boyer-Kendrick, & Dolny, 2000; Fatouros et al., 2000; Jensen, Ebben, Blackard, McLaughlin, Watts, 1999: Jensen, & Ebben, 2003).

Recently science has confirmed the assumptions of coaches and the research in laboratories has proved that exchanging more and less demanding exercises can lead to significant training effects and strength improvement (Blakey & Southard, 1987; Ebben & Blackard, 1998; Duthie, Young, & Aitken, 2002).

The implementation of bigger physical loading, such as pre-loading, improves explosive movements. Exercising with loading causes a temporarily better performance of the following action due to the increased stimulation of the central nervous system (Jensen et al., 1999; Fatouros et al., 2000).

Excitation of the central nervous system is the result of the acute physiological adaptation, which lasts between 8 and 10 minutes and it is called Postactivation Potentiation - PAP (Sale, 2002).

The essence of PAP is the influence of exercises with big loading which causes a high level of stimulation of nerves and results in the involvement of a greater number of motor units and a higher frequency of discharging neural impulses. There are two basic ways of applying the complex training:

1) Combining big and small loading between the series of exercises
2) Combining big and small loading during the series, so called, super-series.

In this research the second method was used and it represents grouping two or more exercises which are done in one big series (super-series), while the exercises with bigger and smaller loading are done interchangeably with the maximum speed. This method is known as the "Russian complex".

Method

The sample consisted of 40 basketball players (Serbian league west): 20 basketball players from the experimental group and 20 from the control group all aged between 16 and 18. They were subjected to both initial and control measurement of the explosive leg power. The initial measurement was done in September, while the control measurement took place in November, after two weeks of the treatment.

With the purpose of evaluating explosive leg power the following tests were applied (the best result was taken into account):

1) Sargent Jump Test – reached height (cm) (Bašćevan and Antekolović, 2008).
2) Standing Triple Jump (cm) and
3) Standing Jump (cm).

These tests of motor abilities were applied in both initial and final measurement in the same groups of examinees. The tests belong to the group of composite tests with three units of measurement, while only the best results were used for the statistical data processing.

The experimental programme lasted ten weeks. The experimental group, apart from regular basketball trainings, had complex trainings in a gym twice a week, while the control group had only technical tactical basketball trainings. The experimental group used 3-5 exercises for lower limbs in order to strengthen them.

Every exercise done by the basketball players from the experimental group consisted of preloading which was 50-80% of one-rep. max (1RM). This level of performance was established by measuring the absolute strength of every individual player. After preloading and a 2 min break specific exercises without loading took place (e.g. half squat with preloading as the basic exercise, followed by half-squat standing jumps without loading as a specific exercise). Preloading was performed in 4 series with 6-8 repetitions, while specific exercises were done with 10 repetitions. The break between the series lasted 4 minutes.

Statistical data processing consisted of the arithmetic mean (M) and standard deviation (SD) of all measuring units for all three tests of motor abilities. It was followed by establishing the reliability of the tests by applying Cronbach's alpha coefficient in both initial and final measurement for both groups of examinees. After that basic descriptive statistical values of motor variables of the initial and final measurement were established: M, SD, minimum (MIN) and maximum (MAX) values of the results of measurements.

Univariate analysis of variance (ANOVA) was implemented with the purpose of establishing the effects of the training programme between two tests. Univariate analysis of covariance (ANCOVA) was used with the purpose of establishing (statistically significant differences between the initial and final measurement)

Results

Prior to the statistical data processing, the reliability of motor measuring instruments was established. In accordance with the data processing, the coefficient of reliability was established using Cronbach's α coefficient, since the motor tests were composite and included three units. In order to establish the reliability, the group of examinees and the time of measurement (initial and final) were also taken into account.

Table 1.

Reliability of composite motor tests used in the experimental group of basketball players for the initial and final measurement.

Masurement	Test	*M*	*SD*	α
	Sargent Jump Test (cm)			0,82
I	1. Sargent Jump Test (cm)	297,70	8,05	
N	2. Sargent Jump Test (cm)	297,85	8,37	
I	3. Sargent Jump Test (cm)	297,95	8,42	
T	**Standing Triple Jump (cm)**			0,88
I	1. Standing Triple Jump (cm)	586,80	17,92	
A	2. Standing Triple Jump (cm)	586,50	18,29	
L	3. Standing Triple Jump (cm)	588,45	29,13	
	Standing Jump (cm)			0,83
	1. Standing Jump (cm)	213,90	15,88	
	2. Standing Jump (cm)	213,00	14,64	
	3. Standing Jump (cm)	210,80	13,27	
	Sargent Jump Test (cm)			0,91
	1. Sargent Jump Test (cm)	303,25	8,97	
	2. Sargent Jump Test (cm)	300,10	10,66	
F	3. Sargent Jump Test (cm)	299,50	9,93	
I	**Standing Triple Jump (cm)**			0,80
N	1. Standing Triple Jump (cm)	592,20	17,34	
A	2. Standing Triple Jump (cm)	591,80	18,96	
L	3. Standing Triple Jump (cm)	596,95	20,15	
	Standing Jump (cm)			0,83
	1. Standing Jump (cm)	218,85	12,72	
	2. Standing Jump (cm)	219,75	13,94	
	3. Standing Jump (cm)	218,15	12,27	

α - Cronbach's coefficient of reliability, *M* - arithmetic mean; *SD* - standard deviation

Values of the coefficient of reliability for the experimental group of basketball players indicate that the greatest reliability belongs to Sargent Jump Test in the final measurement ($\alpha = 0,91$). Other motor tests showed good reliability when used for the evaluation of explosive leg power in the initial and final measurement.

Taking the values of the arithmetic mean into account, it can be concluded that in the initial measurement of Sargent Jump Test the examinees from the experimental group of basketball players had the best average result in the third attempt. In the first two attempts they obviously practiced the technique of the jump, while in the third they did their best and had the best result. In the final measurement the best average result was achieved in the first attempt. In other two attempts the results were worse. The best result in the first attempt can be the consequence of the previous experience the basketball players had in the initial measurement, which certainly influenced the results in the first attempt after ten weeks.

In the second test (Standing Triple Jump) used for the evaluation of the explosive leg power, the basketball players from the experimental group achieved the best average results of the initial and final measurement in the third attempt. Having understood the task, they did their best and achieved the best results. The technique necessary for doing a triple jump was adjusted to the power of legs and it resulted in having the best results in the third attempt. In the first two attempts the players just practiced the technique of the jump.

When the basketball players from the experimental group were subjected to the test Standing Jump, they achieved the best average results of the initial measurement in the first attempt. The fact that the values of the results decreased in the attempts that followed proves that they had the greatest strength in the first attempt. In the final measurement the best average results were achieved in the second attempt. Then they used all their potentials and did their best.

The examinees from the experimental group are extremely homogeneous in all three attempts in both initial and final measurement, which is indicated by the values of the arithmetic mean and standard deviation. It can be concluded that all basketball players from the experimental group are on similar levels of development of explosive leg power.

The greatest reliability in the control group of basketball players was showed by the test Standing Triple Jump ($\alpha = 0,86$) in the final measurement. The results of the analysis of reliability showed by the test of motor abilities in the control group of basketball players in the initial and final measurement indicate high reliability of these tests when they are used to evaluate the explosive power of legs.

The average results of the variable Sargent Jump Test show that this group of basketball players had the best results in the initial and final measurement during the first attempt when they did the exercise with the greatest strength and achieved the best results. In the second and third attempt the average results were gradually becoming lower in both initial and final measurement as the consequence of the lack of strength in leg muscles.

Table 2.

Reliability of composite motor tests used for the control group of basketball players in the initial and final measurement.

Measurement	Test	*M*	*SD*	α
	Sargent Jump Test (cm)			0,80
I	1. Sargent Jump Test (cm)	298,35	7,42	
N	2. Sargent Jump Test (cm)	296,50	5,62	
I	3. Sargent Jump Test (cm)	291,58	7,67	
T	**Standing Triple Jump (cm)**			0,80
I	1. Standing Triple Jump (cm)	584,95	22,68	
A	2. Standing Triple Jump (cm)	588,70	11,97	
L	3. Standing Triple Jump (cm)	590,65	13,30	
	Standing Jump (cm)			0,80
	1. Standing Jump (cm)	213,25	10,61	
	2. Standing Jump (cm)	209,75	13,58	
	3. Standing Jump (cm)	211,55	10,24	
	Sargent Jump Test (cm)			0,85
	1. Sargent Jump Test (cm)	298,35	6,03	
	2. Sargent Jump Test (cm)	295,65	6,56	
F	3. Sargent Jump Test (cm)	294,70	4,89	
I	**Standing Triple Jump (cm)**			0,86
N	1. Standing Triple Jump (cm)	586,50	15,81	
A	2. Standing Triple Jump (cm)	585,55	12,94	
L	3. Standing Triple Jump (cm)	581,85	13,69	
	Standing Jump (cm)			0,82
	1. Standing Jump (cm)	214,65	12,40	
	2. Standing Jump (cm)	211,90	9,79	
	3. Standing Jump (cm)	214,45	10,05	

α - Cronbach's coefficient of reliability, *M* - arithmetic mean; *SD* - standard deviation

In the test Standing Triple Jump, the best average results of the initial measurement were achieved in the third attempt. Having learned how to perform the task in the previous two attempts, the players were ready to achieve the best average results. In the final measurement, having enough experience from the initial measurement, the basketball players from the control group achieved the best result in the first measurement, while in other two attempts the results were weaker, as the consequence of leg exhaustion.

The basketball players from the control group achieved the best results in the test Standing Jump in the first attempt in both initial and final measurement when they used the knowledge of performing the jump (technique of the jump), as well as the strength of legs. They coordinated the movements of legs and arms and achieved the best results. In latter attempts their average results were somewhat weaker, which was the consequence of muscle exhaustion and the decrease of the level of strength.

Similarly to the basketball players from the experimental group of examinees, the players from the control group were also homogenous in all tests in all three attempts (in both initial and final measurement. The fact that the development of the explosive leg power is synchronized is supported by the values of arithmetic mean.

The values of the results of arithmetic means and standard deviations (Table 3) indicate that the basketball players from the experimental and control group are homogenous in both initial and final measurement for all three motor variables. These basketball players are on similar level of development of explosive leg power to other players of their age. Being homogenous is the consequence of the selection of basketball players in their clubs and a similar type of trainings which players are mostly exposed by their coaches.

Table 3.

Basic descriptive statistical values of motor variables

Measurement	Variable	Group	*M*	*SD*	*MIN*	*MAX*
Initial measurement	Sargent Jump Test (cm)	Experimental	302,35	7,15	290	322
		Control	300,45	5,57	290	310
	Standing Triple Jump (cm)	Experimental	597,95	20,34	550	630
		Control	594,60	11,36	577	610
	Standing Jump (cm)	Experimental	220,15	12,38	195	245
		Control	218,00	10,77	195	236
Final measurement	Sargent Jump Test (cm)	Experimental	304,85	8,74	285	328
		Control	299,75	5,73	291	312
	Standing Triple Jump (cm)	Experimental	604,85	8,56	570	645
		Control	595,85	13,10	571	615
	Standing Jump (cm)	Experimental	225,60	9,86	209	245
		Control	219,80	9,69	201	235

M–arithmetic mean; *SD*–standard deviation; *MIN*–min. values of the results; *MAX*–max. values of the results

The analysis the results from Table 4 showed that there are statistically significant differences (p = 0,04) between the experimental and control group of basketball players only in the variable Sargent Jump Test in the final measurement on behalf of the examinees from the experimental group. There were no noticeable statistically significant differences for other motor variables in the initial and final measurement. Both groups were almost on the same level before the experimental programme.

Table 4.

Results of univariate analysis of variance of motor variables (ANOVA)

Measurement	Variable	*F*	*p*
Initial	Sargent Jump Test (cm)	0,88	0,36
	Standing Triple Jump (cm)	0,41	0,52
	Standing Jump (cm)	0,34	0,56
Final	Sargent Jump Test (cm)	4,77	**0,04**
	Standing Triple Jump (cm)	3,14	0,08
	Standing Jump (cm)	3,52	0,07

F-value of F-test; *p*-the level of statistical significance of *F*-test

Table 5 shows the results of the univariate analysis of covariance which indicate the existence of statistically significant differences in all three motor variables on behalf of the experimental group of examinees after the experimental treatment "Russian complex" was applied. After the effect of initial measurement was neutralized the examinees from the experimental group of basketball players achieved statistically significant and better results in comparison to the examinees from the control group of basketball players in all three motor variables: Sargent Jump Test (p = 0,01), Standing Triple Jump (p = 0,05) and Standing Jump (p = 0,03).

Table 5.

Univariate analysis of covariance for motor variables (ANCOVA)

Variable	Group	M^*	*F*	*p*
Sargent Jump Test (cm)	Experimental	303,92	8,45	**0,01**
	Control	300,72		
Standing Triple Jump (cm)	Experimental	603,52	4,26	**0,05**
	Control	597,22		
Standing Jump (cm)	Experimental	224,92	5,11	**0,03**
	Control	220,52		

*M**- corrected arithmetic mean; *F* - value of the relation of statistical significance of differences among the groups; *p* - level of statistical significance of F-relation

Discussion

Having applied the "Russian complex" of exercising in a gym, the purpose of which was to generate the muscle power through additional trainings during the period of ten weeks, the examinees from the experimental group improved their results in all three motor variables used for the evaluation of explosive power and achieved statistically significant improvement in all three variables in comparison to the examinees from the control group.

The use of higher loading for gym exercises, which served as warm-up exercises, caused the improvement of explosive leg power of the basketball players from the experimental group. Doing exercises with high loading allowed temporary improvement of the following action due to the increased stimulation of the central nervous system. These results have been confirmed by the research (Jensen et al., 1999; Fatouros et al., 2000).

Using the basic principles of the "Russian complex" of exercises, combining high and low loading between the series of exercises and combining high and low loading inside a series, so-called super series, has led to the increase of power in leg muscles in the experimental group of basketball players.

Taking into account that the applied experimental protocol has proved to be effective in working with young basketball players, further research verification is required, as well as the control of factors which were not the subject of this research (gender, SES, variables which are related to a court, club, etc.)

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