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Differences in the explosive force of the lower limbs between female volleyball teams

Diferenţe ale forţei explozive la nivelul membrelor inferioare între echipele de volei feminin

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Abstract

Background. The explosive strength of the lower limbs is a sine qua non in determining the level of performance in the game of volleyball.

Aims. Determining parameters for explosive strength of the lower limbs by using two tests of the Bosco Protocol in two volleyball teams, CSU Medicina Tg. Mures and CSM Lugoj, which met in the last round of playoff for disputing the 5th place in the final standings to ensure participation in Eurochallenge.

Methods. To achieve these objectives we used two tests: the squat jump test (SJ) and the stiffness test (STIFF), which were measured using the Optojump Next System device. The evaluation grid test includes 5 steps, numbered from 1 to 5 (1-insufficient, 5-best) values for each test. For the SJ test the evaluation grid is: 1=<32 cm, 2=32-37 cm, 3=38-42 cm, 4=43-47 cm, 5=>47 cm and for the STIFF test, the average power is calculated following the scale: 1=<36 W/kg, 2=36-39 W/kg, 3=40-46 W/kg, 4=47-54 W/kg, 5=>55 W/kg. The rating scale is a personal proposal.

Results. The Tg. Mures team, who won the confrontation, had better results in terms of the parameters of explosive strength in the legs, at the level of the entire group. For the CSM Lugoj team, the SJ test results ranged from 35.5 to 36 cm (2-poor) versus the results of CSU Medicina Tg. Mures, which ranged from 41.8 to 43.3 cm (3, 4 - medium, satisfactory), while average power (STIFF test) for the Lugoj team was between 43.8 to 50.51 W/kg, and for the Tg. Mures team it ranged from 38.44 to 45.11 W/kg.

Conclusions. Physical training is the basis of all components of sports training and improving explosive strength of the lower limbs should be done through plyometric exercises consisting of jumping with and without load. They are the easiest way to increase and optimize elasticity and reactivity level in muscle workouts for physical training.

Key words: Optojump,volleyball, explosive force.

Rezumat

Premize. Forţa explozivă la nivelul membrelor inferioare reprezintă o condiţie sine qua non în determinarea nivelului de performanţă în jocul de volei.

Obiective. Determinarea parametrilor forţei explozive la nivelul membrelor inferioare prin folosirea a două teste din protocolul Bosco asupra echipelor de volei feminin C.S.U. Medicina şi CSM Lugoj, echipe care s-au întâlnit în ultimul act al play-off-ului, în vederea disputării locului 5 în clasamentul final, loc care asigura participarea în Eurochalenge.

Metode. Pentru realizarea obiectivelor s-au folosit două teste: Squat jump test (SJ), Stiffness test (STIFF), acestea fiind măsurate prin utilizarea dispozitivului Optojump Next System. Grila de evaluare a testelor cuprinde 5 trepte, numerotate de la 1 la 5 (1-insuficient, 5-bun), cu valori pentru fiecare test în parte. Astfel, pentru testul SJ grila de evaluare este: 1=<32 cm, 2=32-37 cm, 3=38-42 cm, 4=43-47 cm, 5=>47 cm, iar pentru testul STF, media puterii calculate are următoarea grilă: 1=< 36 W/kg, 2=36-39 W/kg, 3=40-46 W/kg, 4=47-54 W/kg, 5=>55 W/kg. Scala de evaluare este o propunere personală.

Rezultate. Echipa din Tg. Mureş, care a câştigat confruntarea, a obţinut totodată rezultate mai bune din prisma parametrilor forţei explozive la nivelul membrelor inferioare, la nivelul întregului lot. La echipa CSM Lugoj, pentru testul SJ rezultatele au variat între 35,5-36 cm (2-slab), comparativ cu rezultatele echipei CSU Medicina Tg. Mureş, care au variat între 41,8-43,3 cm (3, 4 - mediu, satisfăcător), iar media puterii (STF test) pentru echipa din Lugoj a fost între 43,8-50,51 W/kg, iar pentru cea din Tg. Mureş a variat între 38,44-45,11 W/kg.

Concluzii. Pregătirea fizică stă la baza tuturor componentelor antrenamentului sportiv, iar îmbunătăţirea forţei explozive la nivelul membrelor inferioare trebuie să se realizeze prin exerciţiile pliometrice formate din sărituri cu şi fără încărcătură. Acestea reprezintă modalitatea cea mai la îndemână pentru creşterea şi optimizarea nivelului elasticităţii şi reactivităţii musculare în antrenamentele destinate pregătirii fizice

Cuvinte cheie: Optojump, volei, forţă explozivă.

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Introduction

Maximal strength represents the support in the development of dynamic strength and subsequently, of explosive strength (Bompa & Carrera, 2006). The explosive power of the lower limbs is an important condition for determining the level of performance in volleyball (Cengiz, 2005). The explosive strength of the lower limbs is the most important aspect from the point of view of physical training, on which each coach of a volleyball team, irrespective of the age or level of training of that team, tends to focus. This explosive power is an essential part of many specific abilities of volleyball players, which allows them to perform actions with the high and necessary power, at the right moment. The utilization by volleyball players of the explosive power in jumps, frontal and lateral movements, is critical. The relation between the explosive power and the level of tehnical and tactical training of a player is obvious when observing the actions of the player during the attack and serve (Lehnert et al., 2009; Shetty, 2002). A high level of explosive power in the lower limbs will have a positive effect not only on the height of the vertical jump but also on the speed of movement (Bompa, 2002). Because the volleyball field has reduced dimensions, the movements are very short and fast, and the level of getaway power, acceleration power and detachment power represents a very important aspect of physical training (Bompa et al., 2002).

The maximal performance power in athletes needs to be tested periodically using specific sport tests and laboratory tests (Shetty, 2002). There are similar studies of evaluation and analysis of the explosive force of the lower limbs (Bosco et al., 1983; Castagna et al., 1982; Kenny & Gregory, 2006; Hoffman & Kang, 2002). The authors of studies who used the Optojump Next System device, were: Veligekas et al., 2012; Markovic, 2007; Rabahi et al., 2013; Bosco, 1999.

Hypothesis

The identification of the level of explosive force of the lower limbs is a necessary condition for modeling physical training specific to the game of volleyball.

Objectives

The aim of our study is to measure and evaluate the explosive force of the lower limbs in two female volleyball teams, which play in division A (Bosco et al., 1983).

In carrying out this study, we proposed to objectively determine the parameters of explosive force of the lower limbs by using two tests of the Bosco protocol in two female volleyball teams, CSU Medicina Tg. Mures and CSM Lugoj, which met in the last round of play-off to dispute place 5 in the final classification, which ensures the participation in the EuroChallenge Cup.

Material and methods

Research protocol

a) Period and place of the research

The research was carried out between March - May 2013, in Tg. Mures, in the play-off period of the National League of Volleyball, Division A.

b) Subjects and groups

The study group included 22 senior female subjects, players of the CSU Medicina Tg. Mures (N=11) and CSM Lugoj (N=11) teams.

We mention that in accordance with the Declaration of Helsinki, the Protocol of Amsterdam and Directive 86/609/EEC, the approval of the Ethics Commission was obtained from the CSU Medicina Tg. Mures and CSM Lugoj for the purpose of research in human subjects, as well as the informed consent of the subjects participating in the research.

c) Tests applied

In order to determine the level of explosive force, two tests were used: the squat jump test (SJ) and the stiffness test (STIFF), using the Optojump Next System device.

The first test, the *squat jump test (SJ)* (2, 3), was performed to determine the explosive strength of muscles and the muscle fiber recruitment ability of each player.

Protocol – The player performed one jump inside the two rails. The player had legs bent at 90^0 and hands on hips. The height reached by the center of gravity was determined (Fig. 1).

Fig. 1 – Description of the squat jump test (SJ) (5).

The second test, the *stiffness test (STIFF)* (2, 3), was performed to determine muscle elasticity and muscle reactive force.

Protocol - Inside the two rails of the Optojump device, the player performed 7 successive jumps on two legs without bending the knees. The average height reached by the center of gravity and the average power were determined (Fig. 2).

Fig. 2 – Description of the stiffness test (STIFF) (5).

These two tests described above were performed using the Optojump Next System (1). This system consists of two rails placed on the ground. One of these is the receiver and the other is the transmitter, each with the dimensions of 39.4 x 1.2 x 1.6 inches and containing between 33 and 100 leds. It is able to measure with 1/1000th second precision. Using the tool can measure the time of flight and the time of contact with the ground during each jump executed within these two rails. The two rails communicate at all times, and the system

detects any interruption of communication between the two rails. The program that comes with Optojump Next System can calculate dynamic power, muscular elasticity, average power. The evaluation scale of the tests consists of 5 steps, from 1 to 5 (1 - insufficient, 5 - good) with values for each test (Tables I and II) (Bosco, 1999).

Table I

Evaluation scale for the squat jump test.

Height of center of gravity (cm)	Insufficient				Good
	1	2	3	4	5
Squat jump test (cm)	< 32	32 - 37	38 - 42	43 - 47	> 47

Table II

Evaluation scale for the stiffness test.

Average power (W/kg)	Insufficient				Good
	1	2	3	4	5
Stiffness (Pwr)	<36	36-39	40-46	47-54	>55

d) Statistical processing

For the processing of the results, we used the Optojump Next System device software, which allows to create the database and calculate dynamic power, elasticity and average muscular power, and for the graphical representations of the results, we used Microsoft Office Excel 2007 (4).

Results

Table III

Results of the CSM Lugoj team.

Player	Position	SJ (H)	Stiffness (H)	Stiffness (PWR)
L.D	Outside hitter	35.5	39.1	50.51
L.V.	Outside hitter	37.6	41.4	45.38
L.L.	Outside hitter	36	36.9	43.89
C.I.	Outside hitter	31.9	35.1	45.22
I.A.	Libero	30.8	36.6	41.58
G.C.	Middle blocker	33.8	34.3	44.28
V.I.	Middle blocker	40.1	42	44.93
G.I.	Middle blocker	30.2	35.2	39.93
M.S.	Opposite blocker	23.6	26.2	30.99
I.R.	Opposite blocker	28.7	25.8	36.92
T.D.	Setter	31	33.9	47.51
	TOTAL	359.2	386.5	471.14

Table IV

Results of the CSU Medicina Tg Mureş team.

Player	Position	SJ (H)	Stiffness (H)	Stiffness (PWR)
S.A.	Outside hitter	43.3	38.9	45.11
T.A.	Outside hitter	41.8	41.5	38.44
F.M.	Libero	42.0	33.0	39.93
I.R.	Middle blocker	44.4	31.1	35.75
G.V.	Middle blocker	37.4	33.7	35.18
M.C.	Middle blocker	33.9	31.5	33.5
P.C.	Middle blocker	36.7	28.8	35.82
T.G.	Opposite blocker	39.7	31.9	40.36
I.F.	Opposite blocker	32	28.5	35.82
P.A.	Setter	44.9	45.0	55.14
C.L.	Setter	34.2	33.2	44.44
TOTAL		430.3	377.1	439.49

Legend

SJ (H) - results of the squat jump test expressed in cm
STIFF (H) - results of the stiffness test expressed in cm
STIFF (PWR) - average power obtained in the stiffness test expressed in w/kg

The results of the two tests were extracted from the analysis by the Optojump device software and tabled. The SJ test determined the height reached by the center of gravity of each player and the STIFF test determined both the height reached by the center of gravity and power (Bompa & Carrera, 2006).

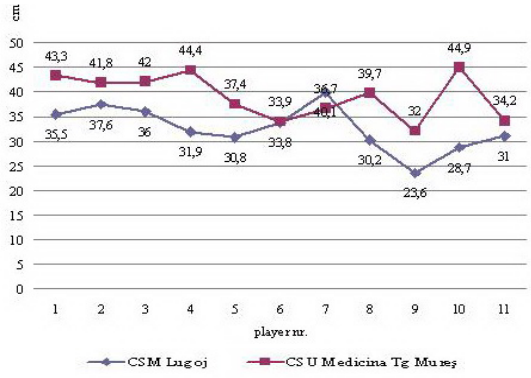

Fig. 3 – Results of the squat jump test.

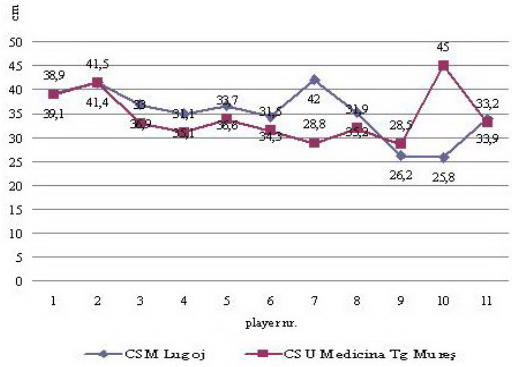

Fig. 4 – Results of the stiffness test.

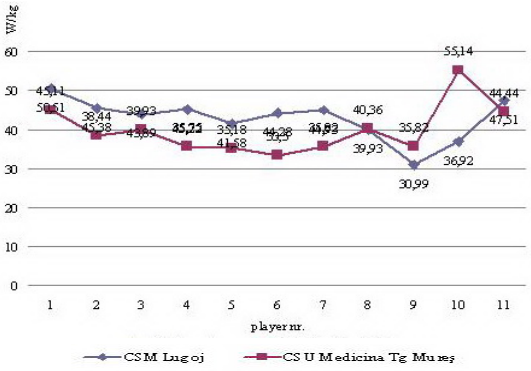

Fig. 5 – Results of the stiffness test (power).

Discussion

From the data extracted as a result of the two tests, the following are evidenced: in the squat jump test, the CSU Medicina Tg Mures team achieved superior results if we take into account the entire team, compared to the CSM Lugoj team. The sum of the average height reached by the center of gravity after the jump on two legs according to the Protocol for the execution of the test shows that the Mures team achieved a result of 430.3 cm, compared to only 359.2 cm obtained by the Lugoj team. In the stiffness

test, the team from Lugoj had better results both in terms of average height and power. If we consider the entire group of players, the sum of average jumping height was 386.5 cm in the case of the CSM Lugoj team, and 377.1 cm for the CSU Medicina team. The average power obtained by the Lugoj team had a value of 471.14 W/kg for the entire team, compared to the Tg Mures team, which reached a value of only 439.49 W/kg. The use of the plyometric method in the physical training of volleyball players has been in the attention of several authors (Miller et al., 2006; Sandler, 2005).

From the perspective of the two assessment scale tests, the team of Tirgu Mures obtained the scores 3, 4 - medium, satisfactory for the entire group in the squat jump test, and the team from Lugoj had values corresponding to the score 2 - weak. In the second test, the stiffness test, the Lugoj team had better results compared to the Tg. Mures team. According to the assessment scale, the team from Lugoj obtained scores between 3 and 4, while the team from Tg. Mures obtained scores ranging between 2 and 3. The reasons for better improvements of the results in the monitored groups may be multiple. We believe that a factor can be considered intense positive training, which was prior to the introduction of the plyometric exercise program (6). A similar progress in dynamic speed following a plyometric training program has been reported by other authors (Zháněl & Lehnert, 2004; Zapletalová, 2002; Lehnert et al., 2009; Myer et al., 2006), who suggest that follow-up of a physical training program through plyometric exercises determines increases in the speed of execution and the height of jumps.

Conclusions

1. In the squat jump test, the CSU Medicina Tg Mures team obtained superior results compared to the CSM Lugoj team, which shows a higher level of explosive force of the lower limbs.
2. In the second test, which assesses muscle elasticity and reactivity, the CSM Lugoj team had better results compared to the CSU Medicina Tg Mures team.
3. For modeling physical training in the two teams of players, in order to optimize the level of lower body explosive strength, elasticity and muscle reactivity, the recommendation for the CSM Lugoj team is to include submaximal and maximal strength training, development charges adapted to each player, while the CSM Medicina Tg. Mures team should focus on plyometric exercises consisting of jumping, with and without load, as the easiest way to increase and optimize elasticity and muscle reactivity levels for physical training.

Conflicts of interests

Nothing to declare.

Acknowledgments

The evaluation scale of the tests was adapted from the work „Strength ASSESSMENT with the Bosco's test", Italian Society of Sports Science, Rome, 1999.

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