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CHANGES OF THE STRENGTH MUSCULAR POTENTIAL OF THE ELBOW FLEXORS FOLLOWING A SIX-WEEK EXPERIMENTAL PROCEDURE IN A GROUP OF RESPONDENTS PERFORMING SHORTENED AMPLITUDES IN CONDITIONS WHEN MUSCLES HANDLE EXTERNAL LOADS

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Abstract

A six week training program for improvement of strength of muscular elbow joint flexors was designed for 7 respondents in order to assess possible changes in the maximal strength. Each of the respondents worked 3 times a week, making 3 series at the Scott bench with a one hand dumbbell as an external load and one to three repetitions in each series. The program of the performed training was with individual approach. At each series, the exercises made by each respondent were changed (intensified), in terms of repetitions in one series, but not more than 3 repetitions. The respondents performed shortened muscular contractions of the elbow flexors in conditions when muscles can endure maximal external load (while showing a maximal angle of peak torque). This manner of individual approach of exercising the maximal strength in muscular flexors, contracting the muscles in angles where the muscular tissue suffers maximal external load, allows quick and efficient change of this ability and it can be applied in the areas of sport, recreation and rehabilitation.

Key words: *muscular strength, elbow flexors, 3 weeks, individual program, maximal load*

Introduction

The maximal strength that can be demonstrated by a person in individual movements is an ability of a person to recruit all potential he/she carries inside which are necessary to handle an external load.

The ability to manifest the strength abilities is determined by central, peripheral and biological factors (Jovanovski,1988): central factors (mechanisms for internal muscular coordination through the number of impulses of motor neurons and frequency of impulses; mechanisms for inter muscular coordination (exact timely activation of agonists, antagonists, synergists and fixators); peripheral factors (mechanical conditions in which the muscles are activate, histological composition and cross-section of muscles); as well as biological factors (Gajic,1985) (morphologic characteristics and physiological-energetic processes). As in each training process, the specifity of the ability being transformed should be implemented in the training procedure. Lifting the maximal weight has a large number of effects on the neuromuscular complex: maximal number of motor units are activated, the fastest muscular units are activated, the frequency of motor impulses sent to the neuromuscular junction is increased, which allows a highly synchronized activity (Zatsiorsky & Kraemer,2006).

The assessment of the maximal strength potential of muscles is mostly carried out through a motor test whereas the external load is being handled in one repetition maximum -1RM (Milenkovski et al.). In practice, dosaging of the external loading is carried out upon the indicators for maximal strength of an individual (RM).

Purpose of this research is to assess the possible change of the strength component in muscles in conditions of full and shortened amplitudes of contraction of muscular flexors of the elbow joint.

The main idea for exercising this type of muscle contractions is based on the theory of the physiological processes in muscle contraction (sliding filament theory), located at the level of sarcomer (Ronald,1993, Rassier, MacIntosh, Herzog). This theory explains the core of the muscle contraction. The actin myosin fibers are differently overlapping in the course of the muscle contraction and in different angle positions of the moved joint while making any movement. Overlapping of myofibril components in

the sarcomere and returning in the initial position is actually the manner of contraction of the muscle fibers (Guyton 1978). Exercising with modified movements (partial amplitudes) is also used for training methods in body building (Sessions; Alessi, Szczepanik.,Wilson, Sisco).

Workout Program

The respondents (N=7) were assigned to do the workout program whose objective was to increase the muscle strength of the flexors of the elbow joint of the non-dominant arm. The experimental procedure took 6 weeks (Ramsay et al., 1990; Moss et al., 2004; Marx, et al. 1998). The respondents were exercising performing muscle contractions on the Scott bench with a one hand dumbbell, 3 times a week, 3 series at a training (Fleck & Kraemer1996). The intensity of the load was given in percentage and it was 90% from the indicator of the test for one repetition maximum -1RM. The purpose of the program was to allow individual approach of exercising of each respondent, as a result of which the load intensity was a variable factor "from one series to another" in the course of one training. (Jovanovski 2013). It was an imperative for each respondent to raise sufficiently heavy one hand dumbbell, not exceeding the repetition of 3 times in a series (Becker,2003). In that manner we have provided scalar increases of the muscular load which always was in the zone of 90% of 1RM. The break between the series was limited to 3-5 minutes (Zaciorski,1975; Kukolj,1996).

The respondents performed shortened muscle contractions of the elbow flexors in conditions when muscles handle maximal external load.

(Верхошанский, 1977). The angle range of muscle contractions was defined by the isokinetic test for the angle of peak torque conducted at the initial testing. This test has shown that the peak torque of the strength was achieved by the respondents at the angle of 75^0 in an attempt for flexion. The amplitude in which the muscle contractions were used was 15 degrees +/- in terms of the middle angle, which means that the movement amplitude of muscle elbow flexors was in the range of 60^0-90^0 (measured from maximal extension to flexion). Thus, exercising the involved muscles was stimulated in conditions when the muscles could handle a maximal external load. (Zaciorski, 1975)

The respondents were tested at the beginning, after 3 weeks and at the end of the sixth week of the experimental program.

Results and Discussion

The mean handled weight (Table No. 1), when bending the elbow, tested with the 1RMBI test of the pilot research, is 13,43kg (Sd=1,21). After 21 days of exercising the respondents of this group have increased the average lifted weight for 21%, which is statistically significant (p=0,018) which is evident from Table 5.

Table No.1 Measures of the central and dispersive statistical parameters for maximal strength of the elbow flexors, assessed with the 1RMBI test at initial, control and final testing

1RMBI	N	Mean	Median	Min	Max	S.d	Skew	Kurt	K-S	Shapiro-Wilk
initial	7.00	13.43	13.25	12.25	15.00	1.21	0.50	-1.68	d=.20807, p> .20	W=.84607, p<.1157
control	7.00	16.25	16.25	12.50	20.00	2.39	0.00	0.36	d=.15790, p> .20	W=.97424, p<.9277
final	7.00	19.89	20.00	15.50	23.50	2.75	-0.30	-0.44	d=.11454, p> .20	W=.98121, p<.9625

Table No.3 Percentage differences in the 1RMBI test at initial, control and final testing

	%		
test	ini-con %	con-fin%	ini-fin%
RMBI	21.0	22.4	48.1

Also, in the second part of exercising (from the 3rd to the 6th week) there is statistically significant increase of the average results obtained from the control testing (22,4%, p=0,018). Significantly increased results (48,1%, p=,0018) occurred in the period from initial to the final measuring. From the analysis one can conclude that changes in this segment in E3 experimental group are not accidental, but they are an effect from the realized strength experimental procedure. The changes occurred are much alike the

changes when the same muscle groups are engaged to move with the overall amplitude or when muscles move with the biggest muscle effort, 0^0-30^0 from extension to flexion Vuksanovikj V, Jovanovski J, Saiti A, 2014)

Table No.4 Analysis of variance of the values from the test for one repetition maximum 1RMBI, for the three time points (pilot, control, final)

Friedman ANOVA - E3, ИНИ-КОН-ФИН				
тест	Chi Sqr.	N	df	p-level
1RMBI	**14.00**	**7**	**2**	**0.001**

Table No.5 Wilcoxon (Post Hoc) test for the 1RMBI test

Wilcoxon Matched Pairs Test (phdv5ka.sta)				
	N	T	Z	p-level
initial/control	**7**	**0**	**2.37**	**0.018**
initial/final	**7**	**0**	**2.37**	**0.018**
control/final	**7**	**0**	**2.37**	**0.018**

Conclusion

Realization of the shortened amplitude in the exercising program in this group of respondents caused significant changes of the maximal muscle strength for the period of 6 weeks.

Although this experimental procedure (according to the author's knowledge) is unique, yet, the changes that have occurred are similar to other experimental procedures which had had other kinds of targeted shortened amplitudes (matrix system and alike, Vuksanovikj, 2008, Vuksanovikj and Jovanovski 2010, Vuksanovikj V, 2010, Moss B. .,1996). Permanent increase of the weight (in order to keep the number of repetition in a series of 3 repetitions maximum) at each training, provided a qualitative muscle stimulation, which has probably contributed to increase the strength capacity of the respondents in a relatively short period of time with a qualitative positive transformation (Vuksanovikj V, Jovanovski J, Saiti A, 2014)

The analysis leads to a conclusion that the changes in the respondents in this segment of muscle strength capacities are not accidental, but they are an effect from the realized strength experimental procedure.

This system of loading provides adaptation not only for the muscle tissue but for the other functional levels as well. (Jovanovski,1988; Zatsiorsky&Kraemer, 2006) and application and combination of different amplitudes of movement in the elbow joint proved to be efficient for muscle adaptation and training effect from the experimental procedure.

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