MUSCLE BIOMECHANICAL QUALITIES MONITORING IN HEAVY ATHLETICS

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Abstract

The aim of our research is theoretical and experimental substantiation of training block schemes and myotonometry in a training process. The subjects of the research were 20±1.2 year old adolescents who had trained in sport before and thus were familiar with the exercise training technique. Strength expression forms testing, stating experiment, myotonometry to state muscle biomechanical qualities and methods of mathematical statistics to process the research results were used in the research. The research had two stages, and the training block schemes were applied in the second stage. The research results showed that applying block schemes in the second stage of the training process significantly increases the results of strength expression form tests had been observed, and it composed on average 8.88±0.2 units against 5.64±0.4 units after the first training stage when the block schemes were not used. By monitoring muscle biomechanical qualities we discovered that in the muscle tone and stiffness tests almost all block schemes had significant dynamics. In the muscle elasticity test only three block schemes had significant result dynamics. It can be concluded that these block schemes can be used to increase elasticity what stimulates blood, water and nutrient circulation during the load, and it takes place exactly thanks to the exercises of stato - dynamic character, which are very popular in bodybuilding kinds of sport.

Key words: *myotonometry, heavy athletics training process*

Introduction

Nowadays it is important to state the most effective means to increase one's work capacity, as well as time economy. Many means are available, they are structured and offered to people in different ways, however following commercialization and advertising campaigns people may lose their initial purpose of starting physical activities in some sport or individually, they may give in under the pressure of commercials. The thigh extensors were chosen as the research object as it was easier both to do testing on them and influence them with different training means. During the research the efficiency of the block schemes in realizing the training process variety principles were stated, the most suitable block scheme or a set of block schemes were looked for. Efficient means, amount, methodology and dynamics when applied to the men aged 20±1 should be substantiated scientifically that would allow use these means for a wide range of people.

So the aim of our research was theoretical and experimental substantiation of training block schemes and myotonometry as a method to determine muscle biomechanical qualities.

Matherial and methods

The research carried out by us took place in the centre of biomotor ability monitoring at the LASE.

To carry out the aim of the research a training subject group was formed including men aged 20±1.2. The total number of the subjects was 27, they constituted one training group. The research was divided into two stages, and each of them lasted for one month. Testing was done before the research, where the subject strength expression forms were tested. The following tests were made: bench press in a special mechanical device, leg press, pull ups, kettle bell clean and jerk and standing long jump. These tests show separate strength expression forms which will be used in the substantiation of the block schemes and muscle biomechanical qualities. The training classes in the

first stage lasted for one month and took place three times a week. The training block schemes were not applied. The whole forming of the training means was based on exercise forming process structure.

After the first research stage a repeated testing of strength expression forms was done, it was necessary for the result dynamics after the research. The following block schemes were used in the second stage: the antagonist superset – in this method after putting the load on the agonist muscle, at once the load is put also on the antagonist muscle. This method is the most often used to develop the flexor/extensor muscles of the upper arm, lower arm, thigh and lower leg. In our research mostly the strength expressions of the thigh muscles were investigated, so we used this method with exercises – the flexion and extension of the legs on a special device. This method was also used for the leg adduction/abduction in "crossover" device and in the combined device, as well as for the leg flexion/extension in the same devices. The shortened amplitude – in this method a movement is done in shortened amplitude what usually constitutes the last 20 degrees of the possible exercise amplitude, thus the exercise execution is done in stato - dynamic regimen when the muscles are in continuous tension both in concentric and eccentric regime, and however, the movement trajectory is short. Isometry – applying this method the weight should be held in one point of the trajectory for definite time. Instead of the number of repetitions here time units may be used, the applied weight is sub-maximal or maximal. The exercise is used in weightlifting and power lifting to develop maximal strength in the definite point of the trajectory of the exercise without increasing the muscle mass. It is used in simple open kinematical chain exercises, and it helps to train the overcoming of the most difficult point of the trajectory. Usually the holding time is small and the weight is close to maximal or even exceeds it.

After the research a repeated testing of strength expression forms was done, as well as the monitoring of muscle biomechanical qualities what was done with the help of myotonometric measuring device MYOTON-3, we could investigate such muscle biomechanical qualities as frequency, elasticity and stiffness. Frequency characterizes muscle tension caused by natural contractions. If muscle tone is normal, then the frequencies of the variation are from 11 to 16Hz, it also depends on the type of muscle. Elasticity characterizes muscle ability to obtain the initial form after the contraction. Usually elasticity values are not bigger than 1.0 – 1.2 depending on the type of muscle, for a trained muscle they can be from 1.0 to 0.6. Stiffness characterizes muscle ability to resist form changes caused by some outer power. Its values are from 150 to 300Nm (9). MYOTON was invented at the Institute of Biophysics, Tartu University, and all over the world it does not have any analogue (Vain, 1999). It is based on tenzo - resistance what registers the frequency, speed and acceleration from the material (muscle) surface of rebound impulses. The greater is muscle stiffness, the less is rebound amplitude and greater rebound frequency. The method of myotonometry is based on the principles of physiology and biomechanics in muscles.

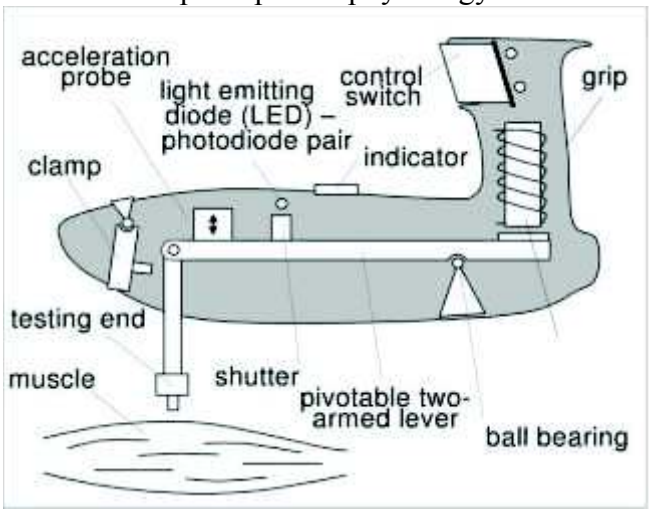

Figure 1. Miotonometric measure device MYOTON-3 (Myoton, 2010).

The muscle stretching with a following measurement was included in the testing to offset the immediate effect caused by the load and we could judge the muscle adaptation abilities.

Results

In the end of the research we had a large amount of the data that were processed with the methods of mathematical statistics. The testing of the strength expression forms done in the research proved that after the second stage of the research the indices of the strength expression forms have considerably increased. The result increases after the first stage was on average 5.64±0.4, but the result increase between the second stage was 8.88±0.2.

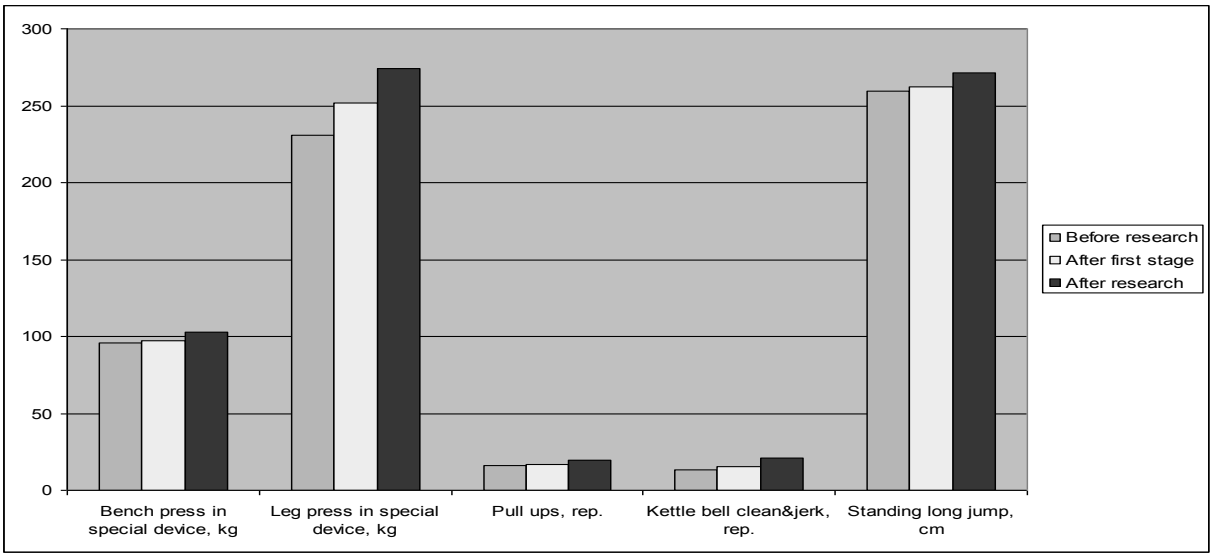

Figure 2. Dynamics of strength expression form test results (n=27; p<0.05)

To substantiate the efficiency of the training block schemes we processed the results of the muscle biomechanical quality monitoring.

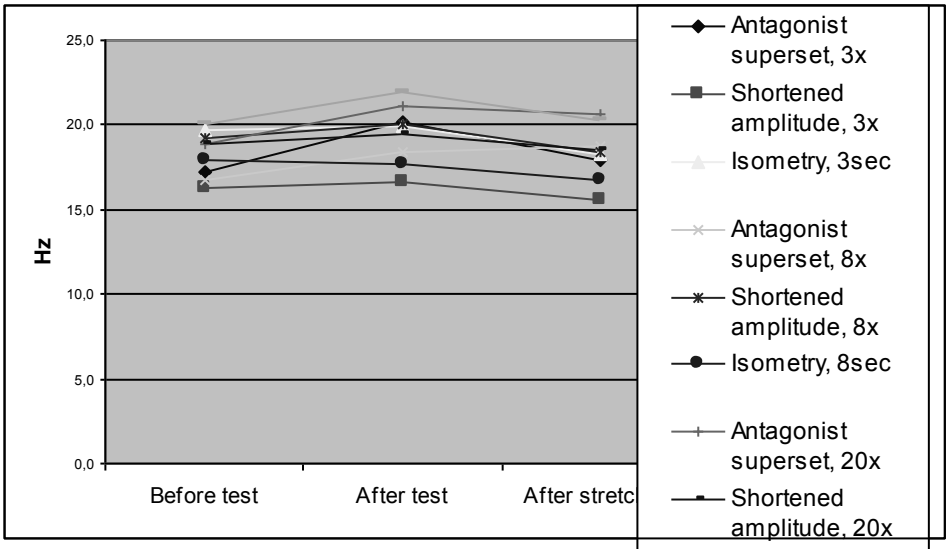

Figure 3. Frequency dynamics, Hz. (n=27; p<0.05)

The results were obtained that showed the dynamics of frequency, elasticity and stiffness before the test, after the test and after the stretching of the muscle.

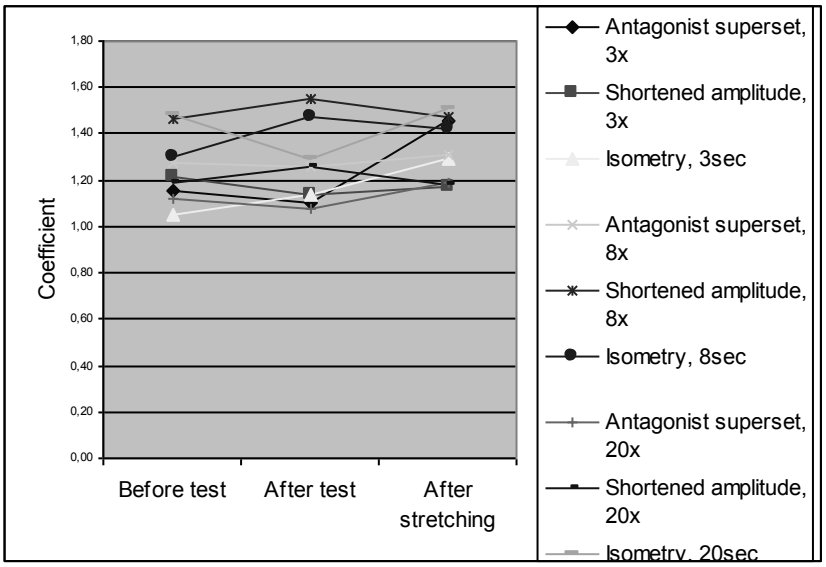

Figure 4. Elasticity dynamics, coefficient (n=27; $p<0.05$)

The results of the biomechanical quality monitoring were a lot, but only the average results were processed.

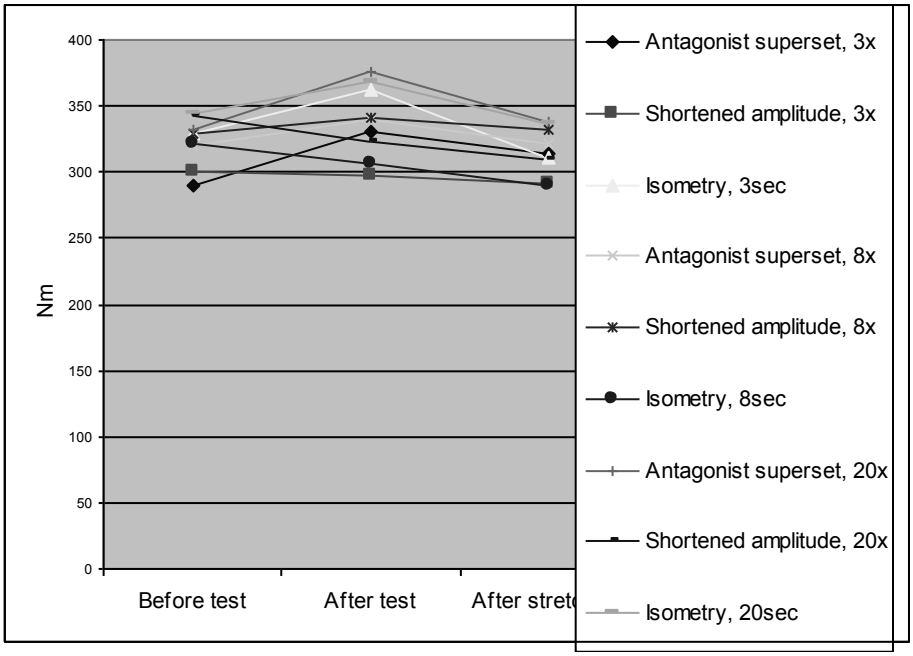

Figure 5. Stiffness dynamics, Nm (n=27; $p<0.05$)

Discussion and conclusions

The dynamics of the strength expression form results was positive, especially in the second stage of the research when the training block schemes were included in the training plan. It allows conclude that variety is the basis of not only top sports achievements, but also of general physical condition, what is shown by the result increase in all strength expression form tests (Čupriks, 2002). Various strength expression forms were tested, what means also the inclusion of different adaptive mechanisms in the execution of the task during the test, as well as mobilization of different energy reserves and kinds of energy production (Čupriks, Ciematnieks, Lesčinskis, 2008). Choosing the research subjects who were practically healthy men aged 20±1.2 we avoided from the influence of different age peculiarities and sensitive periods on the subjects undergoing the test what allows us relate the research results to all social groups, observing individuality of separate subjects (Čupriks,

Knipše, 2006). The results of the research showed that applying the block schemes in the second stage of the research training process significant increase of strength expression form test results were observed that constituted on average 8.88±0.2 units against 5.64±0.4 units after the first training stage when block schemes were not applied. The monitoring of muscle biomechanical qualities was used in the research to state the efficiency of the block schemes including them in the training process with different number of repetitions. Measurements of muscle biomechanical qualities were made with the muscle being relaxed what offset the increase of separate indices (Gavronski, Veraksitš, Vasar, Vain, 2007). According to the results of the muscle tone biomechanical tests we can say that the only result, which we cannot take into consideration, is the block scheme isometry, as its dynamometry is insignificant. Other results are significant and testify the fact that the muscle tone for all test subjects is increased (above 16Hz) what shows that the muscles are trained (Myoton, 2010). It should be pointed out that increased muscle tone not only shows that the muscles are trained, but also makes blood circulation in the muscle and the recovery ability more difficult, as well as it can lead to micro-injuries or injuries (Vain, Viir, 2000). We conclude that the classes with weights with any repetition number increase the muscle tone what is normal for athletes and is advisable with different diseases.

Investigating the muscle elasticity we know that the bigger it is, the better is the functional condition of the muscle, the less is the elasticity coefficient (Vain, 1999). According to the results the only significant dynamics is of the block schemes in the shortened amplitude with eight repetitions, isometry with eight seconds and the shortened amplitude with 20 repetitions. The shortened amplitude with eight repetitions has a large elasticity coefficient (on average 1.5±0.4), this can be explained by non-efficiency of this block scheme variant doing eight repetitions, but doing 20 repetitions the coefficient is much smaller (1.2±0.3), and its value is within the norm (0.6 – 1.2). It proves the fact that executing exercises in the stato-dynamic regime it is recommended to do big number of repetitions with small intensity, even with one's individual weight. It will allow the muscle to recover better during the load, if intensity is increased, the elasticity will also increase and the blood flow in the muscle will be disturbed, as well as its adaptation ability (Roja, 2005). The measurements show that it is useful to use the isometry block scheme with eight second resistance (1.3±0.2).

The muscle stiffness determines the economy of one's active movements of the locomotor apparatus. In the results we see that only the shortened amplitude with three repetitions, isometry with eight seconds and the shortened amplitude with 20 repetitions do not have significant dynamics. The dynamics of other results is significant. We can conclude that other training block schemes can be used in the training process, and from the point of view of muscle stiffness dynamics they do not endanger the results of strength expression forms. It can be explained by the fact that the subjects go in for physical activities which move the lower extremities, so the muscle stiffness increases, the muscle receives more blood, water, nutrients, as well as the increase of the muscle stiffness is a normal defensive mechanism of the body what protects the muscle from overstretching and maintains its continuous readiness to move. The results of the research testify the efficiency of the training variety principles, as well as the influence efficiency of the most of the block schemes on strength expression forms.

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