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Review Article

On the Issue of Performing Stretching Exercises in the Preparatory Part of Training Sessions for Jumpers and Sprinters

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Abstract

The preparatory part of physical exercise is an important part of "pulling" the body into the upcoming activity. In this part, the tasks of preparing muscles and tendons are solved. It must be remembered that the impacts experienced by muscles, tendons and the entire musculoskeletal system as a whole, when performing jumps and sprinting, reach 400 kg or more, while the impact time is 0.1s [8]. Under these conditions, the boundary conditions of norm and trauma arise.

There is a belief among coaches that there is no mastery without injury. And high achievement sports are simply not possible without the methodological principle of sports training - "the unity of gradualism, with a tendency to maximum loads" [4]. And this is really justified by the fact that only above-threshold training influences stimulate training, adaptation processes in the body. Therefore, it is impossible to avoid overloads when training highly qualified athletes. However, contrary to these arguments, injuries are still the scourge of training in sports.

The vulnerable part of the musculoskeletal system in a sprinter is the hip, the pathology of which is 43.02%. Sprinters most often experience myositis and myoenthesitis (about 15% of all pathology of the musculoskeletal system), as well as paratenonitis (Achilles tendon paratenonitis and Achilles bursitis). Chronic myoenthesitis is mainly localized in the posterior surface of the thigh muscles [6].

Is it possible to somehow avoid or minimize these disruptions in the training of athletes? To realize this desire, it is necessary to properly prepare the body for the upcoming training work, and athletes are helped in this by the so-called "warm-up". The objectives of this part of the training session are:

- Bringing body temperature to working values;
- Increasing the elasticity of muscles and ligaments;
- Adjusting the neuromuscular system to the specific conditions of training activity. In this study, we would like to conduct a revision of the preparatory part of the training session from the point of view of the elasticity of the muscular-ligamentous part of the athlete's musculoskeletal system.

To do this, we conducted a study, the objectives of which were: Research objectives:

1. Conduct a review of exercises and motor modes used to stretch and increase the elasticity of the muscular-ligamentous system.
2. To offer alternative motor modes to increase the elasticity of the muscular-ligamentous apparatus of athletes.
3. Determine the degree of effectiveness of the proposed means and modes of their implementation.

Keywords: *Jerk Exercises; Tissue Extensibility; Microtrauma; Post-Isometry; Dynamic Traction*

Introduction

The issue of elasticity of muscle and tendon tissue inevitably refers us to studies of the deformation effects of Hooke's law [7]. According to his understanding, the highest stress at which the deformation still remains elastic is called the elastic limit. These are plastic deformations. At stresses exceeding the elastic limit, after removing the load, the tissue does not restore its shape, which, from the point of view of sports activity, can be characterized as an injury.

It would seem that in matters of warming up (the preparatory part of the training session), considerable practice has been gained, everything is clear here and there is no need to address the issue of preparing muscles and ligaments to perform motor actions. However, as it turned out, in the problem of increasing elasticity, everything is not so simple.

Let's turn to exercises designed to increase the permissible amplitude of stretching of muscles and tendons, that is, stretching exercises. The traditional and most well-known method is the use of exercises performed in a jerk-like mode (Figure 1).

Figure 1: *The most commonly used jerk-like forward bends, with gradually increasing amplitude, to stretch the posterior muscle group.*

Most often, such exercises are performed in four counts, with a gradual increase in amplitude. They are an indispensable physical education attribute and are most often used in morning hygienic exercises and in school physical education lessons.

However, is this jerky stretching regimen justified for sports practice? In this regard, there are some points that we would like to draw attention to.

Turning to the innervation of the musculo-ligamentous apparatus, we found that muscles have two types of their own receptors: muscle spindles and Golgi tendon organs. Both types of proprioceptors are stretch receptors. So, a sharp stretch of the tendon immediately causes an immediate contraction of the muscle fibers.

An example of innervation to a sharp stretch is the well-known mechanism of the knee reflex [5] (Figure 2).

When you hit your own patellar ligament, the tendon is suddenly stretched. This causes the muscles of the front of the thigh to contract. Let us pay attention to the fact that it is a sharp stretching of the tendon that is the trigger for contraction of the muscles of the anterior surface of the thigh and movement in the knee joint [5].

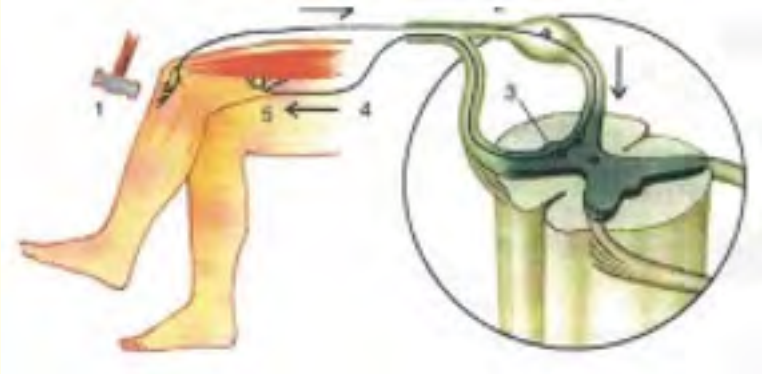

Figure 2: *Diagram of the tendon (knee) reflex.*

But then, by performing jerk-like movements, for example, when sharply bending forward, when stretching the muscles of the posterior thigh muscles, we thereby trigger the command for their contraction. That is, we want to stretch the muscle, but in fact, the jerk-like mode gives the command to contract. Are these jerk-like exercises performed in a fast stretching mode justified then?

In a previous publication [1], we have already examined the issue of the effect of plyometric exercises on muscles, in which a sharp stretching of the tendons also occurs with tense muscles. We concluded that plyometric exercises are percussive in nature. In this case, the use of the word percussion is associated with the word percussio (Latin) - "striking". These percussive impacts inevitably lead to microtrauma of muscle tissue, which entails so-called hyperplasia. This results in micro-grasses of muscle tissue. According to research by A.I. Lebedeva, S.A. Muslimova, L.A. Musina, L.A. Shcherbakova [3], "already in the initial stages, foci of acute inflammation and hemorrhages are detected in the wound". Ultimately, "after 30 days, a regenerate is found in the area of the defect, consisting of muscle, fat and dense fibrous connective tissue".

Is it possible to somehow prepare muscles and tendons for training work in a different way?

An alternative option used in practice is a smooth and gradual stretching of muscles and tendons, without sudden impact, for a longer time (up to 1 minute).

Another very effective way of stretching a muscle is known, through the use of post-isometric relaxation. The physiology of motor activity is such that after strong muscle tension, a mechanism for reducing muscle tone is reflexively triggered. It is this process that underlies post-isometric relaxation. The basic rules for its implementation are as follows. Exercises are performed with a partner. The partner takes the limb and brings the limb to the extreme point, until pain appears. After this, it is necessary to tense the muscle with a force of 70% of the maximum, and the partner counteracts the movement of the limb. The muscle tenses, but no movement occurs. Voltage time 5 - 7 sec. After the tension stops, you need to relax the muscle along with exhalation. Preliminary tension when switching motor activity reduces muscle tone. This is post-isometric relaxation (Figure 3).

When using post-isometric relaxation, the following rules must be observed:

- Muscles must first be warmed up and relaxed with the help of any motor activity, for example, running;
- Stretching should occur gradually, without sudden movements;

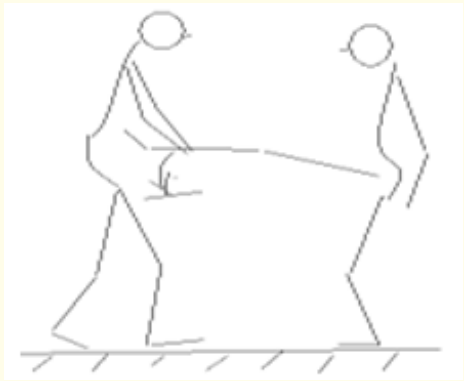

Figure 3: *An example of performing post-isometric stretching of the muscles of the back of the thigh.*

- First you need to bring the muscle into a state of pretension (maximum stretching until pain occurs);
- Muscle tension should occur as you inhale, and stretching should occur as you exhale [2].

But as it turns out, this is not the last word in the practice of using stretching exercises in order to achieve greater muscle elasticity. Representatives of martial arts have good stretching. And they use dynamic traction. Its essence is that when stretching the muscles of the back of the thigh, with the help of a partner, it is necessary to work with the foot (Figure 4).

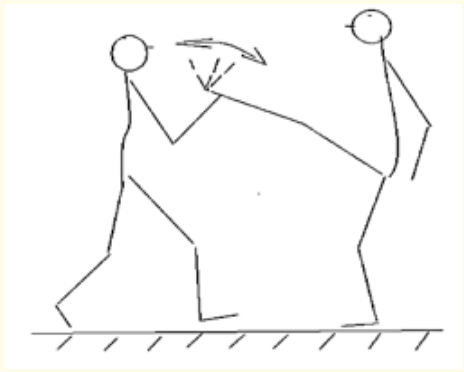

Figure 4: *Example of using dynamic traction.*

To test the effectiveness of using different modes of stretching exercises, we conducted a pedagogical experiment. The participants in the experiment were female track and field athletes aged 14 - 16 years old from the Specialized Olympic Reserve School No. 3 in Novocheboksarsk.

To do this, we created a control and experimental group. Athletes in the control group, in the preparatory part of the training session, used jerking exercises to increase the elasticity of muscles and tendons. And the athletes in the experimental group used slow stretching exercises and dynamic stretching exercises with a partner. In the control and experimental groups, 20 minutes were allotted for this part of the training session. To control the change in the degree of muscle elasticity, we used bends on a gymnastic bench, recording the maximum reach of the fingers to the line of the arms when bending over (Figure 5).

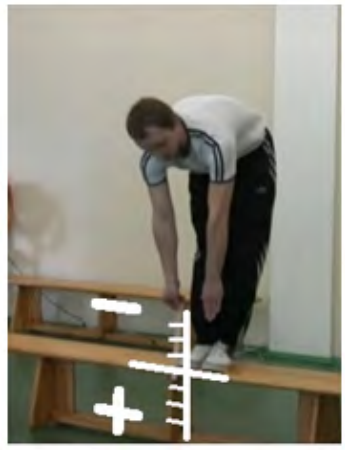

Figure 5: *Testing the elasticity of the muscles of the posterior thigh group.*

The results of the experiment are presented in table 1.

N p/p	Results of the control group				Results of the experimental group			
	Surname	**Before**	**After**	**Growth**	**Surname**	**Before**	**After**	**Growth**
1.	Efremova Ya.	+6	+9	+3	Spirina C.	+2	+16	+14
2.	Dmitrieva M.	+14	+16	+2	Zakharova A.	+7	+17	+10
3.	Andreeva E.	+2	+8	+6	Sharikova A.	+ 9	+23	+14
4.	Sosnova K.	+3	+7	+4	Antonova A.	+6	+18	+12
5.	Timofeeva P.	+7	+9	+2	Korsakova K.	+4	+17	+13
6.	Kazankova Yu.	+4	+8	+4	Agafonova K.	0	+16	+16
7.	Artemieva A.	+6	+11	+5	Yushkova V.	+5	+21	+16
Group average		+6	+9,7	+3,7	Group average	+4,7	+18,2	+13,6

Table 1: *Results of testing the elasticity of the muscles of the posterior thigh group of the control and experimental groups, before and after performing stretching exercises.*

So, in particular, in the control group, the extensibility indicators of the posterior thigh muscles in the control group improved by 3.7 cm, and in the experimental group by 13.6 cm. At the same time, the maximum improvement in the control group was +6 cm, while in the experimental group it was +16 cm. Accordingly, the minimum improvement is +2 cm. and +10 cm. Thus, it can be stated that the stretching exercises used by members of the experimental group who used slow stretching exercises and dynamic stretching exercises were much more effective.

Conclusion

1. Analytics of motor activity showed the absurdity of using jerk-like exercises of a percussion nature.
2. Based on an analytical study, we came to the conclusion that the use of snatch exercises is inconsistent.
3. The experiment showed a significantly higher effectiveness of exercises with gradual stretching of muscles and tendons and dynamic traction exercises.

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