ECRONICON OPEN ACCESS

EC ORTHOPAEDICS
Review Article

Identification of Aberration in the Training of Jumpers and Sprinters Using the Scientific Knowledge of Orthopedics. Correction of the Proportion of Training Means of a Plyometric Nature in the Total Volume of Strength Exercises of Athletes, to Support the Functional Properties of Muscle Tissue

AT Egorov*

"Sports Training Center of the National Teams of the Chuvash Republic Named After A. Ignatiev" of the Ministry of Sports of Chuvashia, Cheboksary, Russia

***Corresponding Author:** AT Egorov, "Sports Training Center of the National Teams of the Chuvash Republic Named After A. Ignatiev" of the Ministry of Sports of Chuvashia, Cheboksary, Russia.

Received: April 13, 2023; **Published:** April 26, 2023

Abstract

As William Shakespeare says in Hamlet:

“It is better to put up with the familiar evil,

How to flee to the unfamiliar to strive! [9].

With these words, William Shakespeare intelligibly explained the reason for the conformity of "familiar" knowledge, which makes it difficult to gain a new understanding. Critic D.I. Pisarev wrote that a new understanding “goes to the one... who throws off the yoke of dominant concepts, who fearlessly swims against the general current and... defeats its resistance” [7].

Abstracting and considering human locomotion from the point of view of orthopedics, we proposed a new understanding of the mechanism of jumping and running. Thus, in particular, avoiding the usual knowledge and dominant concepts in every possible way, we decomposed the aspects of muscle contractions into component parts through the prism of orthopedics and built a different mechanics of jumping and running [1-3].

We have shown that repulsion, interpreted by the former paradigm, in jumping or sprinting, due to the powerful and rapid contraction of the muscles, is not possible due to the very short period of time allotted for the interaction of the athlete with the runway. Under these conditions, only the deformation principle of movement is able to give the athlete a motor impulse [1-3].

This new understanding (gestalt) of jumping and running, of course, required a revision of the entire training system for athletes specializing in running and jumping. However, the introduction of this concept into the practice of training athletes did not bring us the expected results. Our results did not support the new theory.

But the contradictions that arose between the new theory and training practice could not remain unanswered, in connection with which we continued to study the deformative nature of running and jumping in relation to the practice of implementing these concepts in the training process of athletes. To find the reasons, a study was conducted with the following tasks:

1. To investigate the reasons for the negative results of the pedagogical experiment on the introduction of plyometric exercises based on deformation mechanics;
2. Find ways to reconcile the contradictions of the new postulate with the practical training of high jumpers.

Keywords: *Deformation Mechanism; Plyometric Exercises; Microtrauma; Replacement with Fibrous and Collagen Tissue*

Introduction and Research Results

And so, in our analytical studies, we convincingly proved that the muscular-contractile mechanics is not able to provide the required dynamics of running and jumping, which is actually diagnosed.

In our analysis, we relied on the fact that in locomotions with rapid interaction with the supporting surface (t = 0.08 - 0.16 seconds), such as jumping and sprinting, the muscles are simply not able to show the highest strength indicators (250 - 400 kg) [1], in such a short time. Actin and myosin, firstly, are simply not able to move quickly in the viscous environment of the cytoplasm [1,2].

Moreover, for example, in the high jump, we revealed the effect of centrifugal forces, which additionally, more than 300 - 350 kg, burden the athlete's pushing leg. Focusing on these 300 - 350 kg, let's say that this is not just a burden, it is a “yoke”, which, in the phase of the so-called “repulsion”, not only to make a jump, with a vertical take-off speed of more than 4 m/s, even unbend the knee of the jogging leg will not be possible [3].

However, the picture changes 180 degrees in a different interpretation of these encumbrances. In our paradigm, the "yoke" of centrifugal forces, in excess of 300 - 350 kg, suddenly becomes a boon as a force that deforms (stretches) the tendons [1-3].

The same picture was revealed in sprinting, which is related to the high jump in terms of time (0.08 - 0.1s) of interaction with the supporting surface [2]. In sprinting, tendon strain energy is also the driving force. And the force of the deforming tendon is the centrifugal force arising as a result of the work of the hands, as well as the force arising from the active stepping on the support, or, in the words of one of the leading biomechanics in the world, P. Weyand, the force of kicking the track [6]. Figure 1 shows fragments of the initial position of the sprinter before the active impact pressure of the foot on the track.

Figure 1: *Fragments of the position of the sprinter before the shock foot step on the track.*

These fragments clearly show what kind of energy is laid in the initial position of these sprinters for impact on the track. This, in accordance with the analogy of P. Weyand, is similar to the mechanism of jumping on a pogostuck, where the secret of high jumps is shock pressure on it, for greater deformation of the spring (Figure 2).

All this indicates the deformational nature of the interaction of a jumper, or a sprinter, with a treadmill. But that was in theory. In practice, everything turned out to be more difficult.

Figure 2: *Jumping on the pogost by shock deformation of the spring.*

The mechanism based on the deformation nature was intuitively guessed by us at the initial stage of gaining coaching experience (1983-1988). And the search for ways to improve the training of high jumpers led us to the conclusion that it is necessary to abandon strength exercises based on the overcoming nature of muscle work. Instead, we decided to test percussion exercises, one of which is depth jumping exercises, which in the scientific and methodological literature are called plyometric exercises with an eccentric mode of muscle work [4]. To implement the new concept, an experiment was conducted (1986-88) on high jumpers of the training group of the 2nd year of study, the Sports School (city Mariinsky Posad).

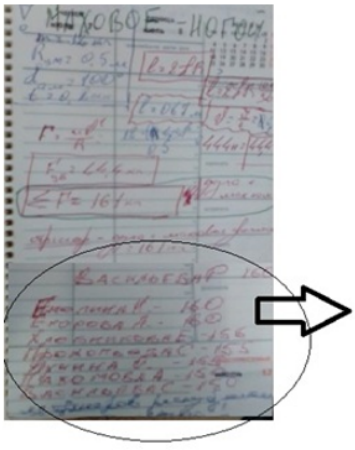
Before the experiment, jumpers were trained in the preparatory period (August-January) according to the following structure:

- Monday - sprint and hurdling training;
- Tuesday and Thursday - strength training with weights (with a partner), on the leg extensors;
- Wednesday and Friday - technical work (sprint, hurdles, jumps);
- Saturday - competitive and test training.

By applying this structure of the weekly training cycle in the preparatory periods of the annual cycle, significant success has been achieved. In the training group, sports categories in the high jump were completed and many medals were won at regional level competitions (Figure 3, column "result before the experiment").

It was decided to carry out further training with the use of plyometric exercises, which, according to the kinematic structure, are as close as possible to the high jump. The use of these training tools suggested even greater progress in vertical jumps. For this, the following exercises were chosen:

1. Jumps over barriers on two legs - 3-4 series of 10-15 jumps. The height of the barriers was 0.76m.
2. Jumps over stuffed balls on one leg - 3-4 series of 10-15 jumps.
3. Jumping from an elevation (up to 90 cm), followed by jumping up - 2-3 series of 8-10 times (Figure 4).
4. Various rope jumps - up to 200 jumps. This set of exercises was performed on Tuesday and Thursday of the weekly training microcycle. On the rest of the training days, the preparation was carried out in the same training structure.



Nп /п	Surname I.	Result before the experiment	Result after the experiment
1.	Vasilyeva R	165	165
2.	Emelina I.	165	165
3.	Egorova L.	165	165
4.	Khlebnikov E.	155	150
5.	Prokopyeva S.	155	150
6.	Luchina O.	150	150
7.	Pakhomova A.	150	150
8.	Vasilyeva S.	150	145
	Average	156,8	155

Figure 3: *The initial level of results in the high jump with a run and the results after the experiment in high jumpers 14 - 16 years old.*

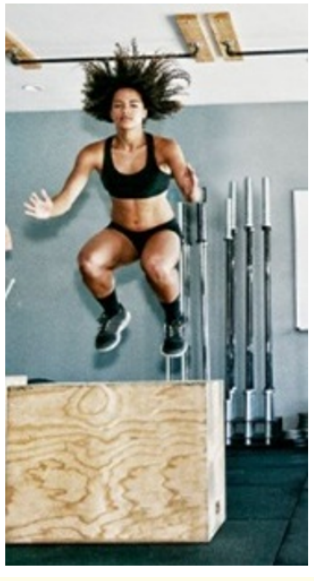


Figure 4: *Exercise with jumping (in-line) from an elevation (pedestal 0,7m.) followed by jumping on it.*

However, contrary to what was expected, after the winter training cycle, we did not get the expected progress (Figure 3, column "results after the experiment").

As follows from the final table, not a single jumper managed to improve the result, in three cases there was a deterioration in the result by 5 cm, in five jumpers the result remained at the same level. The average decrease in the group was 1.875 cm (Figure 3).

Repeated approbation of exercises of a plyometric nature, in the following training seasons, in no case led to a progression of the result and, on the contrary, led to stagnation. Our plan failed.

But why has the theory not been supported by advances in practical application? Later, when working as part of the scientific group of the national team, it was suggested that the massive use of plyometric exercises leads to the degeneration of muscle tissue and the growth of connective tissue elements. This was repeatedly pointed out by the masseurs of the national team. This was later confirmed by data from the scientific and methodological literature. So in the studies of A.V. Samsonova, A.I. Lebedeva, S.A. Muslimova, L.A. Musina, L.A. Shcherbakov shows how the "rebirth" of muscle tissue occurs.

Exercises of a plyometric nature are of the nature of percussion, and the use of hard plyometric work with the nature of percussion inevitably leads to microtrauma of the muscle tissue. A.V. Samsonova showed that in the human body, the formation and destruction of muscle fibers is constantly taking place [8,10]. This is the so-called hyperplasia, in which:

- According to the research of A.I. Lebedeva, S.A. Muslimova, L.A. Musina, L.A. Shcherbakov [5], microtrauma of muscle tissue leads to the fact that “foci of acute inflammation and hemorrhage were found in the wound already in the initial stages.
- In the period of 7 - 14 days, the defect caused by inflammation is replaced by granulation tissue, represented by bundles of collagen fibers infiltrated with connective tissue and immunogenic cells, with a predominance of fibroblast cells: mesenchymal cells, fibroblasts with active collagen synthetic activity, epithelioid cells, and inside the actomyosin complex “muscle fibers were sealed with collagen fibers due to the influx of the sarcolemma... signs of transformation of granulation tissue into fatty tissue were revealed, due to sharply expanded channels of the granular endoplasmic reticulum, numerous lipid drops of various sizes were detected (Figure 5);
- After 30 days, a regenerate was found in the area of the defect, consisting of muscle, fat and dense fibrous connective tissues” (Figure 6) [5].

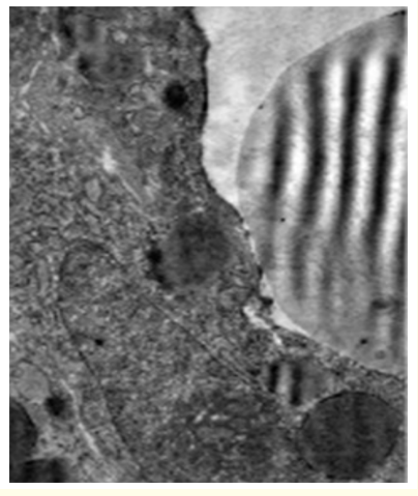


Figure 5: *Electron diffraction pattern of a fibroblast cell 21 days after the infliction of a defect in skeletal muscle tissue (according to Lebedeva A.I., et al. 20) [5].*

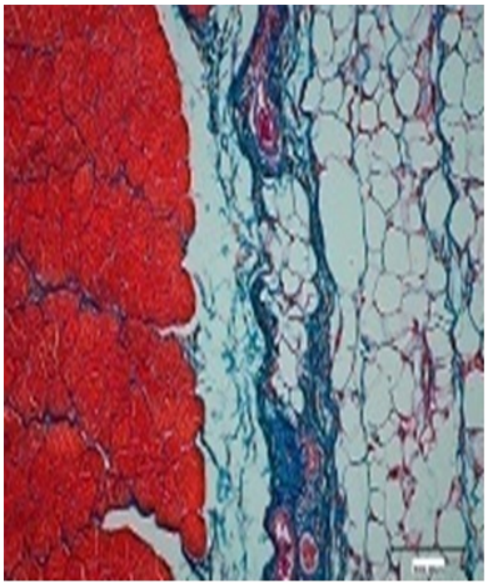


Figure 6: *Fatty degeneration of the connective tissue 30 days after the infliction of a defect in the skeletal muscle tissue (according to Lebedeva A.I. and others) [5].*

Thus, muscle tissue is replaced by lipid cells, connective tissue, limited to the sarcolemma, with granulation of the sarcoplasmic reticulum. That is, on the face of a complete loss of the functional properties of muscle tissue.

It would seem that for us this should not be a negative fact, since our concept does not affect myofibrils at all. However, this additional "birth" of connective tissue structures makes this link excessively rigid, difficult to stretch, with a small amplitude of elastic structures. This ultimately has a negative effect on the height of the "ricochet bounce" in jumps.

These facts led us to the conclusion of a negative trend, with the massive use of exercises of only a shock nature. This indicates the need for the parallel use of plyometric and strength exercises of an overcoming nature (with a reduction in actomyosin) in the annual cycle of training high jumpers.

In the course of further long-term empirical searches, it was found that the optimal ratio of training means in the preparation of athletes of low qualification is:

- 70% - Overcoming mode;
- 30% - Plyometric mode.

For highly skilled athletes, this proportion changes in the direction of increasing the training of the plyometric component (in terms of total number of repetitions):

- 60% - Overcoming mode;
- 40% - Plyometric mode.

At the same time, it was found that overcoming training means should be performed with maximum amplitude. This indicates that these exercises are not aimed at muscle anabolism, but are necessary to prevent the growth of connective tissue structures.

These conclusions, as a confirmation of the previous assumption, in 2011, in oral and written form, were brought to the well-known high jump coach Evgeny Zagorulko, for the introduction of the country's leading jumpers into the training process.

Conclusion

1. Plyometric exercises of a percussive nature are biodynamically similar to the main competitive exercise - a high jump from a run, which includes them among highly targeted, highly effective training tools.
2. However, the complete replacement of low-performance training tools with high-performance plyometric exercises did not lead to the expected progress in results.
3. A study of scientific and methodological literature, to identify the causes of failure, showed that:

1. As a result of the use of plyometric exercises of a percussive nature, the occurrence of microtraumas is inevitable [3];
2. This, within 30 days, leads to the replacement of muscle tissue in collagen, epithelial tissues and sarcolemma, with loss of function of contractility of muscle tissue [2];
3. Excessive "genesis" of the connective tissue worsens the elasticity of the deformable structures of the musculoskeletal system.
4. Long-term empirical search for the optimal ratio of training means in the preparation of athletes revealed the following proportions:

- For athletes of not high qualification, this proportion is:
- 70% - Overcoming mode;
- 30% - Plyometric mode.
- The recommended ratio of training aids in the preparation of highly qualified athletes is:
- 40% - Overcoming mode;
- 60% - Plyometric mode.

Bibliography

1. Alexander Egorov. “The Aberration of the Muscular-Contractile Gestalt Paradigm of the High Jump with a Run is the Reason for Limiting the Physical Capabilities of a Person in Jumping Locomotions”. *EC Orthopedics* 12.11 (2021).
2. Alexander Egorov. “A Different Reality of the Sprint. The Source of Power that Propels the Athlete While Running at Maximum Speed”. *EC Orthopedics* 13.1 (2022).
3. Egorov Alexander. “The Magnitude of the Additional Encumbrance by Centrifugal Forces Arising in the High Jump (On the Example of the Jumps of Olympic Champions Anna Chicherova (London, 2012) and Mutaz Barshim (Tokyo, 2020)”. *EC Orthopaedics* 14.4 (2023): 04-16.
4. Human physiology. Textbook for institutes of physical culture edition 5th. Under. ed. N. V. Zimkina (1975): 496.
5. Lebedeva AI., *et al*. “Regeneration of skeletal muscle tissue of experimental animals induced by alloplant biomaterial”. *International Journal of Experimental Education* (2023).
6. Peter Weyand SCIENCE FYI: What Is the Limit to How Fast A Human Can Run? Scientific and technological advances are making that an awfully complicated question (2013).
7. Prozorov VV DI. “Pisarev: Prince”. for the teacher. M: Education (1984): 112.
8. Samsonova Alla Vladimirovna. What is muscle fiber hyperplasia? Hypertrophy and hyperplasia | Muscle biomechanics (2023).

9. Shakespeare - Hamlet: Verse Translation: Boris Pasternak. Electronic resource (2023).

10. Why Every Runner Should Be Doing Eccentric Exercises/This type of strength training gives you way more bang for your buck (2021).

Volume 14 Issue 5 May 2023