Original Article

Studies of musculoskeletal system of parachutists during development and physical exercise sets performance

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ABSTRACT

The paper presents the results of fundamental and clinical studies of the musculoskeletal system of parachutists, and in the light of the data obtained, recommendations for improving their physical capabilities are detailed. The paper deals with the correct recovery after physical activity as a prerequisite for the health and maximum performance of the parachutist. Principles and tools for the study of the musculoskeletal system. The study of the functional state of myofascial meridians was carried out using the method of myofasciography. This technique helps to objectify the assessment of the functional state of the musculoskeletal system of parachutists and to correct it. The study of the functional state of myofascial meridians of parachutists was carried out under the influence of certain loads in the process of mastering and performing parachute jumps on specialized equipment of the airborne forces complex, which made it possible to identify "weak links" in the state of individual parts of the musculoskeletal system and introduce additional exercises into the training process, eliminating these imbalances. This helps find the right balance between training and competition loads and the recovery component needed to maximize the parachutist's performance. Thus, studies have been carried out on various measures to restore the musculoskeletal system, leading to the introduction of new techniques such as kinesiotherapy as an integral part of the parachutist's training program to achieve this balance.

Keywords: Kinesiology research, Skydiving, Musculoskeletal system, Stretch reflex, Myofascial chains

Introduction

Parachute jumping, like any sport, is associated with muscle work and presupposes a specific distribution of stresses in the myofascial meridians of the body, which inevitably leads to the formation of a special pattern of individual skeletal muscle tones, and is reinforced by the development of "mosaic" hypertrophy. In this case, hypertrophy of some muscles of the meridian may be accompanied by proportional muscle failure of other muscles, not only of another meridian but even of the same one [1, 2].

Here, by myofascial meridians, we mean, based on the ideas of Thomas V. Myers [3, 4], muscles do not work by themselves, but as part of myofascial meridians, where the insufficiency of one muscle must be compensated for by the excessive tone of all other components of the meridians [5]. Accordingly, the treatment strategy should be aimed at analytical development: strengthening weak myofascial meridians and unloading overstrained myofascial meridians. Analytical manipulations with individual muscles or synergistic groups can be carried out only with the use of specialized simulators [6, 7], or manual operations [8].

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Materials and Methods

The study complies with ethical and scientific standards for biomedical research. Informed consent was documented by signing and dating the informed consent form [9].

The practice of sports medicine requires a holistic approach to the study of the musculoskeletal system (MSS). Myofasciography gives a special, holistic picture of the state of the muscular apparatus both within the same myofascial meridian and the relationship between different meridians [1, 5].

Investigations of the functional state of myofascial meridians of parachutists during training camps under the influence of special loads made it possible to identify weak links in the state of individual parts of the MSS and introduce additional exercises into the training process, eliminating these disproportions [5].

As a result of observation of a group of 23 parachutists who were at special training camps, during episodic examinations for four months, we received similar patterns of myofasciograms of parachutists. Over 4 months of studies, the myofasciogram, being a standard pattern for parachutists of this type of sports specialization, practically did not change quantitatively throughout the entire research period. As an example, we present the dynamics of changes in the myofasciograms of two parachutists registered at the beginning and end of four-month training camps **(Figure 1)**.

The preparation of parachutists for mastering and performing a parachute jump is carried out on special equipment of the airborne forces complex. The set of lessons on ground-based training of the elements of a parachute jump includes: inspection of the parachute and fitting equipment at the airfield, boarding an airplane (helicopter), rules for separating a parachutist from an airplane (helicopter), rules for opening a parachute, actions of a parachutist in the air when descending on a parachute, rules for using a reserve parachute, actions when landing (on land or water) and extinguishing the canopy of a parachute, assembling parachutes and stowing them in portable bags.

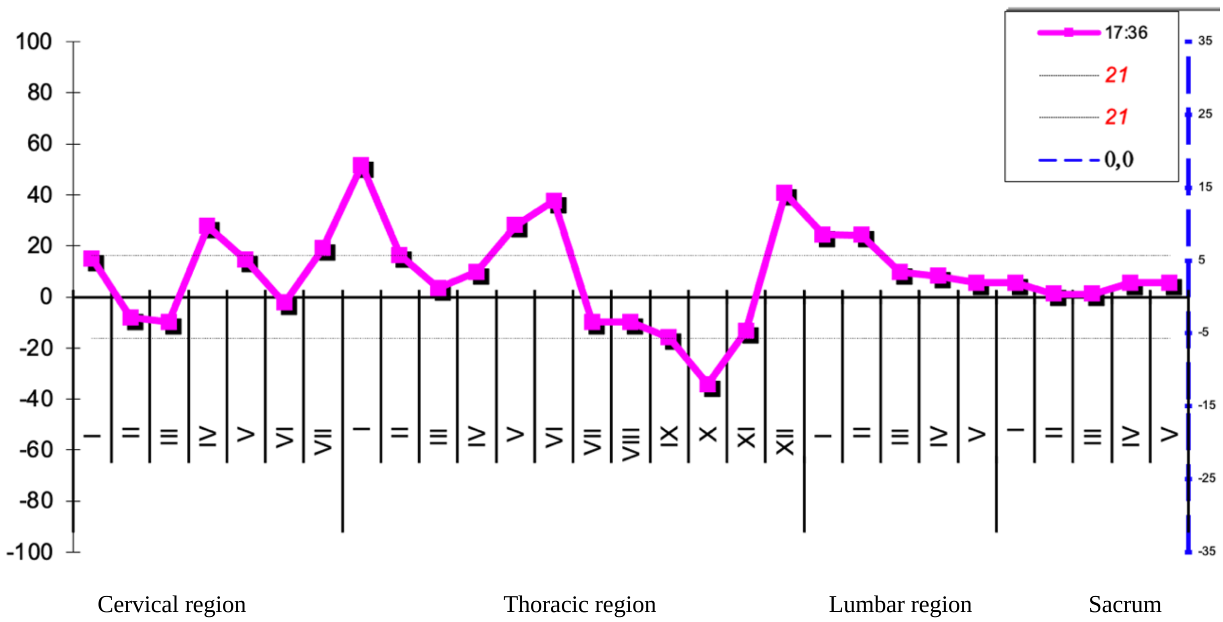
The equipment and simulators of the airborne forces complex for practicing all the actions of a paratrooper when performing parachute jumps include a platform for training paratroopers to perform a parachute jump, high-altitude aircraft simulators (Il-76, An-2), a slipway for suspended jumps with devices for training in the use of a reserve parachute, parachute trampolines with straps, simulators for training to extinguish the canopy while dragging, a simulator for strengthening the ankle joints, a parachute tower.

At all stages of a jump with a specially controlled parachute on a training tower with dynamic loading (accompaniment), the following actions are practiced: rotation and stabilization techniques during free fall, change in body position in roll and pitch when the main parachute is put into operation, as well as when flying with a canopy, at the landing stage, depending on the wind and the correct actions of the parachutist, the speed of the dynamic surface of the Earth changes.

The current examination was carried out on the days of large training loads to obtain information about the course of the training process, the functional state of the athlete's body, the effectiveness of the means of recovery used.

We provide such a complex myofasciogram on purpose because it shows an error in the initial dosage of the load, as well as the dynamics of its correction **(Figure 1)**. Thus, the parachutist had pain in the cervicothoracic and lumbar regions. The first graph **(Figure 1)** clearly shows the hypertonicity of the muscles of these segments. After specialized training, this hypertonicity decreased, which means an adequate load **(Figure 3)**.

Results and Discussion



Explanation: the lines indicate the boundaries of the norm for conventionally healthy men (from +20 to - 20 standard units — s. u.); myofasciogram shows a deviation from the norm (above: hypertonicity, below: muscle failure) of muscles and derivatives of the corresponding myotomes innervated by the spinal cord. The table below shows the standard deviations, by segment.

Figure 1. Functional activity of the spinal motion segment. Myofasciogram of the parachutist in the initial cycle of examinations

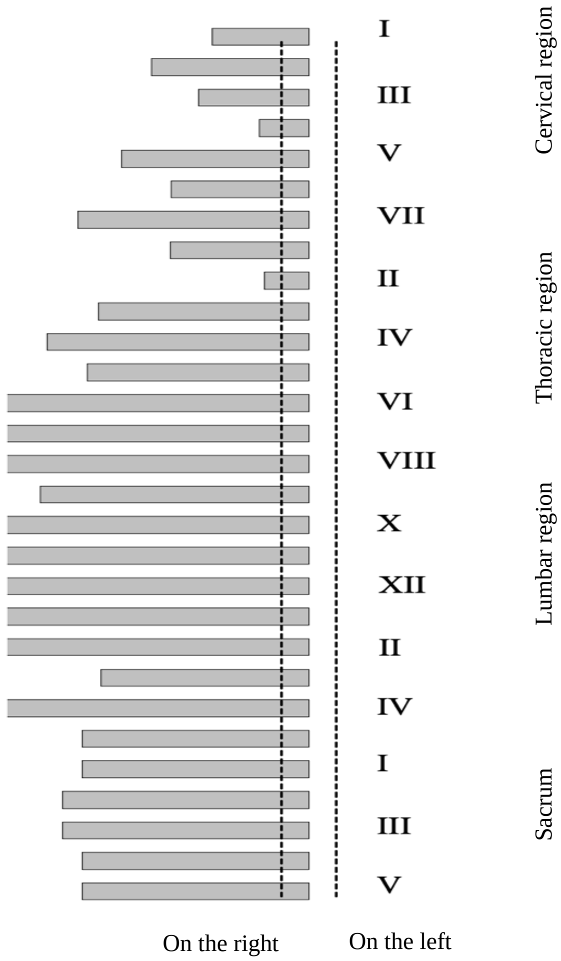
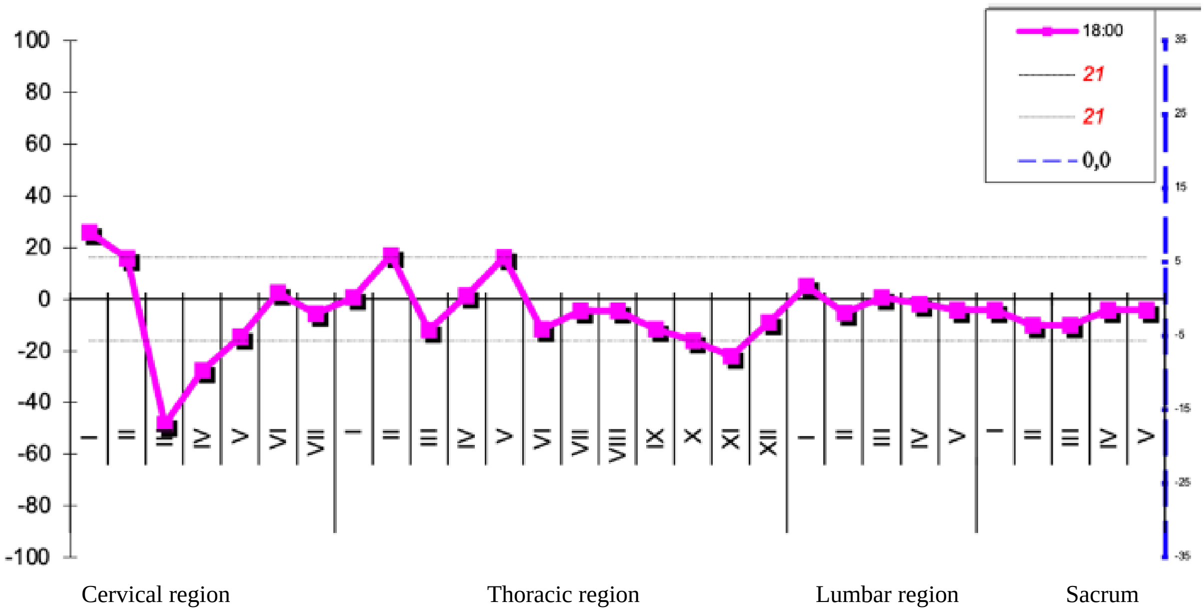


Figure 2. Asymmetry of the spinal motion segment of the parachutist in the initial cycle of examinations. Redistribution of tones (segment by segment): from right to left



Explanation: the lines indicate the boundaries of the norm for conventionally healthy men (from +20 to - 20 standard units — s. u.); myofasciogram shows a deviation from the norm (above: hypertonicity, below: muscle failure) of muscles and derivatives of the corresponding myotomes innervated by the spinal cord. The table below shows the standard deviations, by segment.

Figure 3. Functional activity of the spinal motion segment. Myofasciogram of the parachutist in the final cycle of examinations

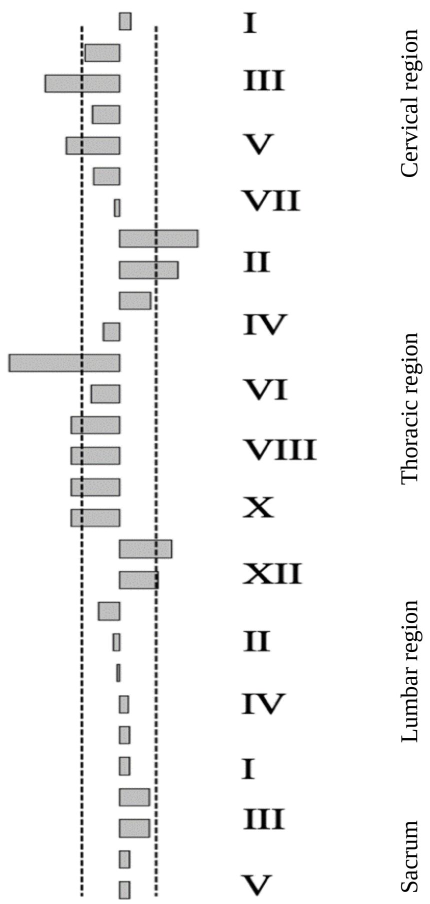


Figure 4. Asymmetry of the spinal motion segment of the parachutist in the final cycle of examinations. Redistribution of tones (segment by segment): from right to left

As an example, myofasciograms of one of the parachutists are presented: before the cycle of corrective training **(Figure 1)** and after twelve analytical pieces of training **(Figure 2)**.

On the graph, broken lines (horizontally) indicate the range of "normal" muscle tone (from 21 to -21 s. u.). Deviation of the indicator upwards shows the degree of hypertonicity, and downwards it shows the degree of muscle failure (in s. u.). **Figure 1** shows a distinct hypertonicity (28 s. u.) of the muscles innervated by the 4th cervical region, 1st (51 s. u.), 5th (28 s. u.), 6th (38 s. u.), 12th (40 s. u.) thoracic region and 1st (24 s. u.), 2nd (24 s. u.) lumbar region. **Figure 1** of myofasciography shows hypotonia in the 10th (-34 a.u.) thoracic region. After a cycle of analytical training, the situation has significantly improved as well the asymmetry of muscle tone (right to left) **(Figure 4)**. **Figure 3** shows a distinct hypertonicity (26 s. u.) of the muscles innervated by the 1st cervical region and hypotonia of the muscles in the 3rd (26 s. u.) cervical region and 11 (-22 s. u.) thoracic region. Before training, the muscle tone is "skewed" to the right **(Figure 2)**, while after training the ratio, to a large extent, has leveled off (dark columns: before, light columns: after training). We believe that for parachutists a uniform right-to-left tone ratio will not allow twisting to one side **(Figure 4)**.

On the example of these myofasciograms, a general pattern of the distribution of muscle tone of the entire MSS is visible, on the one hand, on the other, the "weak" sides of the kinematic chains are visible (excessive and insufficient muscle tone of their components, segment by segment). This makes it possible to purposefully correct the kinematic chains of the MSS in the direction necessary for parachutists, either with the help of special exercises or with other physiotherapeutic means, which is shown on the second myofasciogram **(Figure 3)**.

Here, we can see a characteristic for parachutists called "double-humped" hypertonicity of the muscles innervated by the upper thoracic segments of the spinal cord, with an insufficient tone of the muscles innervated by the lower thoracic segments **(Figures 1-3)**. The picture practically did not change after mastering and performing a set of physical exercises in parachute jumping and returned to the initial state before the next training session. This indicates that it is the specific muscular activity that forms such a pattern of the functional states of the myofascial meridians.

As mentioned above **(Figure 1)**, parachutists form a quite typical pattern of inter-meridian relationships caused by the specifics of parachute jumps. Based on the analysis of myofasciograms, complexes of adaptive exercises were proposed, aimed at normalizing the functional state of different parts of the MSS.

Further, the effectiveness of the therapy was monitored by registering a repeated myofasciogram **(Figure 3)**. As an example of the application of myofasciography, we present a comparative analysis of two graphs: the initial one (before the sessions)

(Figures 1 and 2) and after the sessions **(Figures 3 and 4)** of adaptive exercises in the course of mastering and performing physical exercises and parachute jumps by parachutists. Accordingly, in addition to the main training load, special exercises (analytical) were prescribed for stretching in the areas of hypertonicity, and strength exercises were recommended for the areas of muscle failure (according to the method of S. M. Bubnovskii). As a result, by the end of the training camps for parachutists, distinct improvements and approximations to the norm (boundaries of dashed lines) of the functional state of the muscles were found throughout the space innervated by different segments of the spinal cord.

Thus, with the help of special additional exercises and under the control of myofasciography, it is possible to correct the functional state of the muscle corset of parachutists, thereby preventing further diseases in the form of scoliosis and herniated discs.

Conclusion

The given examples **(Figures 1-4)** show that, in contrast to the methods of manual diagnostics of the state of the MSS, which are exclusively subjective, or instrumental methods of physiology that do not give an integral picture of the functional state of the MSS muscles, the proposed method gives, at the same time, both an integral and an analytical picture of the functional state of individual muscles of parachutists. This method has shown its usefulness when examining athletes in many sports [10], in particular when examining parachutists, and can be recommended for widespread use in sports medicine and kinesiotherapy.

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References

1. Stone WJ, Stevens SL, Fuller DK, Caputo JL. Ambulation and physical function after eccentric resistance training in adults with incomplete spinal cord injury: A feasibility study. J Spinal Cord Med. 2019;42(4):526-33. doi:10.1080/10790268.2017.1417804.
2. Ibrahim S, Al-Ameer A, Abu-Hilal H, Allen J, Watkins P. Effect of Protein Supplementation plus Hyper-Caloric intake and Exercise on Hypertrophy, Hormones and Energy components among Underweight Males. Int J Pharm Res Allied Sci. 2020;9(3):143-53.
3. Wilke J, Krause F, Vogt L, Banzer W. What Is Evidence-Based About Myofascial Chains: A Systematic Review. Arch Phys Med Rehabil. 2016;97(3):454-61. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0003999315010643
4. Myers TV. Anatomy trains: Myofascial meridians for manual and movement therapists. St. Petersburg: Merkulov D.S.; 2007.
5. Ajimsha MS, Shenoy PD, Gampawar N. Role of fascial connectivity in musculoskeletal dysfunctions: A narrative review. J Bodyw Mov Ther. 2020;24(4):423-31.
6. Latash ML. Muscle coactivation: definitions, mechanisms, and functions. J Neurophysiol. 2018;120(1):88-104. doi:10.1152/jn.00084.2018.
7. Kubatbekov TS, Kosilov VI, Prokhorov IP, Demin VA, Savchuk SV, Chylbak-ool SO, et al. Particularities of Individual Muscles and Groups of Muscles Development over the Anatomical Areas of the Carcasses of the Bestuzhev Cattle and Their Crosses with Simmentals. J Biochem Technol. 2020;11(4):46-51.
8. Vasileva LF. Applied kinesiology. Restoration of tone and skeletal muscles. Moscow: Eksmo; 2018.
9. Oganov RG, editor. High-quality clinical practice with the basics of evidence-based medicine: a textbook for the system of postgraduate and continuing professional education of doctors. Moscow: Silitseya-Poligraf; 2011.
10. Tolstykh SS. Physiological mechanisms of changes in the musculoskeletal system, psychological status under the influence of training in athletes doing oriental martial arts. Ph.D. Thesis. 2016.