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## **BALANCE TRAINING FOR THE DEVELOPMENT OF PROPRIOCEPTION IN SOCCER PLAYERS IN THE RECOVERY PERIOD AFTER INJURIES AND SURGERY ON THE LOWER EXTREMITIES**

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**Key words:** soccer, injuries, recovery, balance training, training.

**Annotation.** A method for the formation of physical qualities in soccer players during the recovery period with balance training for the development of proprioception has been developed. It is shown that the use of balance training at the recovery stage of the training process ensures the restoration of lost functions after surgery on the lower extremities and is currently one of the most relevant problems of rehabilitation of athletes, namely amateur soccer players. The obtained results allow us to recommend and apply balance training at the recovery stage of soccer players after injuries and surgery on the knee joints. Balance training provides a gradual application of static and dynamic exercises and takes into account the functional features of proprioceptors. The inclusion of the technique in the physical rehabilitation program for athletes who have suffered injuries and knee joint surgery contributes to the preservation and improvement of results.

**Introduction.** Soccer, as most sports games, is characterized by a versatility of physical actions, it develops almost every physical qualities [1-2]. Because of trauma, a number of these indicators, skills and abilities, as well as physical indicators, reduce, some of them reduce significantly. Consistently, at any stage of recovery and training process, a task is set to restore physical qualities that were lost not because of injury, but because of a long-term withdrawal of an athlete from the training process [3-4].

Recovery of physical qualities and in-game practice of athletes who have suffered injuries and a level of their fitness is an organic part of the training process. The recovery period's feature is that its structure and content imply a combination of general and special training of soccer players with a continuous process of rehabilitation through an inclusion of therapeutic and recovery events for strengthening an injured area of the musculoskeletal system and recovery of the

organism in whole after training loads using means of training, psychological and biomedical nature [5-6].

The Bernstein's concept about a sensory correction (coordination) principle served as a basis for the balance training method. The balance training is a set of physical exercises for developing proprioception, balance and coordination, which are performed in unstable positions, with fit balls, on suspension systems and unstable supports. They activate the work of the nervous system, active and passive stabilizers and receptors, as well as the vestibular system in whole [7-9].

Thus, the main components of the recovery process using methods of the proprioceptive recovery of postural control are:

- 1) use of rotational exercises in all planes;
- 2) use of plyometric (jumping) exercises for developing functional stability;
- 3) use of unstable support for developing balance and coordination;
- 4) performing exercises with eyes closed for better development of sensorimotor control.

Literature data [10-11] indicate a need to develop method for training soccer players at the recovery stage, which, against the background of maintaining indicators of the functional state of an athlete, would eliminate consequences of injury within a short time and recover sports performance and possibility to perform training loads with the highest efficiency and quality [12-13].

It is also important to note that, although main points of the method of training process at the recovery stage after injuries of the lower extremities were developed, there are still unsolved issues and contradictions, i.e. terms for beginning classes, including use of special exercises, the character of performed exercises and ratio of different training means [6, 14, 15].

The purpose of this study was to evaluate an effectiveness of using the balance training method in the system of forming physical qualities in soccer players during the recovery period.

**Methods and organization.** The experimental base of this study was the Tomsk Scientific and Research Center of Balneology and Physiology, branch of the Siberian Federal Scientific and Clinical Center of the Federal Medical and Biological Agency (Tomsk). The study involved 60 men aged 38-42 years – amateur soccer players with an average level of physical fitness and experience of 5-7 years who were in the recovery period after injuries and surgery on the anterior cruciate ligament and the knee joint meniscus.

We formed two groups – the main (40 people) and control (20 people) groups. Both groups were training, according to the recovery period's method, for 3 weeks. We implemented additional balance training sessions for the main group.

Training program of the recovery period for the control group was based on following principles:

1. All exercises were formed in small groups (series), single series have 2-4 repeats;
2. In all series, first and second exercise complement each other (for one muscle group);
3. Variability of exercises and change in modes of the neuromuscular contraction are obligatory.

When developing the balance training method, we followed these principles:

1. Mechanoreceptors, located in cruciate ligaments and meniscuses, react to specific movements and positions of the knee joint. Therefore, we selected exercises in a way that training and development of these proprioceptors were carried out through performing special exercises in positions that would cause a training effect [16].

2. In order to develop muscle sense, performance of exercises began with the healthy extremity. As D.Yu. Pinchuk and M.G. Dudin note, it is needed to teach a patient to distinguish between sense of movement and sense of relaxation and muscle contraction, without which it is not possible to construct the rehabilitation and training process.

3. All exercises were recommended to perform with first eyes opened, then with eyes closed. Visual analyzer is the leading one in managing movement.

The developed complex of balance training exercises, which contributes to improvement of recovery of athletes, included following sets of exercises:

- set of exercises on unstable supports, i.e. balance pillows;
- set of balance training exercises, performed on a fit ball (selection of a fit ball's size is individual). The exercises are performed with opened/closed eyes;
- set of proprioceptive exercises for controlling pose and precision of voluntary movements (dynamic and static balance);
- set of exercises for stretching the tape to different directions, with turns and bends of the trunk;
- going up and down the step platform.

The postural control method as one of used proprioceptive processes for controlling precision of volitional movements (dynamic balance) and poses (static balance) is one of the main processes of recovering vestibular functions of the organism [17]. It includes performance of following exercises:

- 1) rotational exercises, applied in all planes;
- 2) plyometric (jumping exercises) for developing functional stability;
- 3) use of unstable support (balance pillow) for developing balance and coordination;

4) performing balance exercises with eyes opened then closed for better development of sensorimotor control.

Proprioception in the musculoskeletal apparatus can be disturbed due to pain, synovitis, injury and fatigue [17-19]. That is the reason why it is important to reduce pain and effusion through medical intervention in the first place and only after their reduction begin to perform exercises. All balance training exercises with axle loads on the extremity were performed with a knee brace, all exercises were performed with a bilateral support, then – without support.

Therefore, using the developed balance training method and its implementation into the process of physical rehabilitation of athletes after the injury of the anterior cruciate ligament and the knee joint meniscus supports an improvement of recovery process in athletes, maintains higher indicators of the joint's stability, functional recovery of the lower extremities and better motor control of movements. In order to control dynamics of physical indicators, we conducted tests for assessing general and special physical fitness, tests for evaluating balance, assessment of strength of muscles of the lower extremities.

The statistical processing of the material was carried out using the applied software package Statistica 8.0 for Windows made by Statsoft. The descriptive analysis included identification of the arithmetic mean and the mean error: "arithmetic mean $\pm$ mean error" ( $X\pm m$ ). We used the Kolmogorov-Smirnov test to check on the character of distribution of signs in the obtained data.

The comparative analysis of changes, occurred in examined groups, was based on defining significance of difference between indicators according to the Wilcoxon's T-test for not normally distributed parameters, because the formed samples did not correspond with normal distribution. Thus, the use of parametric statistical criteria, based on parameters of populations that are normally distributed, was not acceptable. Hypothesis on compared independent samples, belonging to the same general population or populations with similar parameters, was checked using the Mann-Whitney U-test for independent samples. The critical significance level ( $p$ ) when checking on statistical hypotheses in the study was equal to 0,05.

**Results and discussion.** Table 1 presents results of testing physical fitness of soccer players at the beginning and the end of the pedagogical experiment. As it was shown, there were no substantial differences between groups at the beginning. After the experiment, there is a significant growth of indicators in both groups, but it was higher in the main group than in the control group. For example, when performing a 3\*10 m run, a time of running the set distance decreased in the main group by  $6,5\pm 2,3$  s, in the control group – by  $3,5\pm 2,1$  s ( $p<0,05$ ).

When performing the standing long jump, an increase value amounted to  $4,8\pm 2,1$  m in the main group and  $2,6\pm 1,3$  m in the control group ( $p<0,05$ ).

Table 1

Results of testing physical fitness of soccer players at the beginning and end of the pedagogical experiment

№	Tests	Control group			Main group		
		Before	After	Increase value	Before	After	Increase value
1	3*10 m run, s	24,3±3,3	20,8±3,2*	-3,5±2,1	28,5±3,4	22,0±2,4*	-6,5±2,3#
2	Standing long jump, m	165,1±5,1	168,1±6,9*	2,6±1,3	160,3±9,1	165,1±7,8*	4,8±2,1#

Note: \* – significance of changes after the experiment,  $p < 0,05$ ; # – significance of differences with the control group,  $p < 0,05$

Table 2 presents results of evaluating the balance function at the beginning and the end of the pedagogical experiment. As it is demonstrated from the obtained results, there were no significant differences between groups before the experiment. As a result, increase in all indicators was registered in both groups, but in the main group it was significantly higher. For example, increase in stability time in the Romberg test was  $8,2 \pm 2,3$  s in the main group and  $5,6 \pm 2,0$  s in the control group ( $p < 0,05$ ). An increase in the stability time in the Yarotskij test was  $8,9 \pm 1,5$  s in the main group and  $4,8 \pm 2,3$  s in the control group ( $p < 0,05$ ).

The obtained results indicate that using balance training in the recovery period contributes to an improvement of vestibular stability in athletes.

Table 2

Results of evaluating balance function in soccer players before and after the experiment

№	Tests	Control group			Main group		
		Before	After	Increase value	Before	After	Increase value
1	Romberg test-3, s	26,2±4,2	31,8±4,9*	5,6±2,0	24,5±1,9	32,7±3,5*	8,2±2,3#
2	Yarotskij's test, s	32,2±2,9	37±3,1*	4,8±2,3	25,6±2,9	34,5±2,9*	8,9±1,5#
3	Static balance evaluation, s	32,±3,2	36,1±3,5*	3,6±2,0	23,8±2,9	32,8±2,8*	9,0±2,5#

Note: \* – significance of changes after the experiment,  $p < 0,05$ ; # – significance of differences with a control group,  $p < 0,05$

Table 3 presents results of evaluating strength of the leg muscles in soccer players before and after the pedagogical experiment. Before the experiment, there were also no significant differences between groups. As a result, an increase in all indicators was registered in both groups.

Differences in dynamics of test results that characterize strength of the lower extremities' muscles were not significant, but still reliable. For example, in the "Squatting on one leg" test, an increase in the control group amounted to  $3,3 \pm 1,3$ , in the main group –  $6,0 \pm 2,0$  ( $p < 0,05$ ). The same situation was noted in case of the

standard squat test –  $4,8 \pm 1,9$  in the control group and  $13,0 \pm 4,3$  in the main group ( $p < 0,05$ ).

Table 3

Results of evaluating mobility in the joints and strength of the leg muscles in soccer players before and after the pedagogical experiment

№	Tests	Control group			Main group		
		Before	After	Increase value	Before	After	Increase value
1	Squatting on one leg, times	$18,4 \pm 2,3$	$21,7 \pm 2,6^*$	$3,3 \pm 1,3$	$14,4 \pm 3,5$	$20,4 \pm 4,9^*$	$6,0 \pm 2,0\#$
2	Standard squat test, times	$24,9 \pm 2,6$	$29,7 \pm 2,5^*$	$4,8 \pm 1,9$	$19,4 \pm 3,3$	$32,4 \pm 8,9^*$	$13,0 \pm 4,3\#$

Note: \* – significance of changes after the experiment,  $p < 0,05$ ; # – significance of differences with a control group,  $p < 0,05$

**Conclusion.** The developed balance training method, aimed at recovering proprioception in the lower extremities after surgery on the anterior cruciate ligament and the knee joint meniscus in athletes is a part of physical rehabilitation method. It is carried out both at the functional and the training and recovery stage of the recovery process and includes following exercises: exercises for developing coordination and balance in case of external interferences, as well as pose control and precision of movements for static and dynamic balance.

The results obtained demonstrate that inclusion of balance training in the stage of recovery period allows increasing significantly an effectiveness of the training process, improving results of forming physical qualities in soccer players [28, 20]. Indicators of general physical fitness, balance and strength of the lower extremities' muscles are significantly higher in the main group.

Implementation of the balance training method at the recovery stage allows increasing potential of athletes and contributes to further development of special physical fitness of players (movement coordination, agility, speed, speed and strength qualities) [12, 21].

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