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IMPACT OF THE RECOVERY PROCEDURES COURSE ON THE FUNCTIONAL STATE OF THE MUSCULOSKELETAL SYSTEM OF LOWER LIMBS OF FIELD HOCKEY ATHLETES DURING TRAINING IN MIDDLE ALTITUDE

Yu.V. Kushnareva, S.M. Abutalimova, O.N. Akimkina
FSBI "North-Caucasian Federal Research and Clinical Center of the Federal Medical and Biological Agency", Essentuki, Russia

Annotation. The purpose of this study was to evaluate impact of a set of physical therapy procedures on the functional state of the neuromuscular system and hemodynamics of lower limbs in female athletes in middle altitude conditions during training. The study involved 19 female field hockey players with the Candidate for Master of Sports and Master of Sports titles. They were randomly divided into two groups: the treatment group (had a set of physical therapy procedures, including magnet therapy, hydrotherapy and lymphatic drainage massage (pressure therapy)) and the control group (had no procedures). The analysis of the neuromuscular transmission parameters in the treatment group after the course has revealed an increased amplitude on the left in two stimulation points: head of fibula and popliteal fossa. When analyzing hemodynamic indicators, the treatment group has also demonstrated a significant decrease in the asymmetry coefficient in the "foot" segment of the left and right leg. When analyzing the microcirculation indicators, we have found a decrease in the diastolic index and the left ventricle filling pressure in the "calf" segment of the right leg. Considering the data obtained, we can conclude a positive impact of a set of procedures on the blood flow and the neuromuscular system of female field hockey players during training in middle altitude.

Keywords: field hockey, recovery, middle altitude, training activity, neuromuscular system, hemodynamics, magnet therapy, hydrotherapy, lymphatic drainage massage (pressure therapy).

Introduction. Field hockey is a contact and dynamic situational sport that is actively developing recently in Russia. It requires not only tactical skills, but also great physical impact and good overall endurance from players, since practicing this sport involves mainly aerobic loads. High intensity of physical activity in professional sports, along with the body adaptation to middle altitude conditions, can cause almost an almost marginal level of the body function of athletes and, as a result, create prerequisites for faster fatigue, overstrain and overtraining, thereby reducing the efficiency of training activity [1-4]. That is the reason why the use of effective recovery methods while training elite female athletes in middle altitude conditions is extremely important. During recovery of athletes, experts apply different measures of physical therapy, such as magnet therapy and lymphatic drainage massage (pressure therapy) [5-6]. However, there is no research dedicated to studying efficiency of a comprehensive implementation of physical therapy procedures that include magnet therapy, hydrotherapy and pressure therapy in case of recovering athletes in middle altitude conditions [7].

The purpose of the study was to rate the impact of magnet therapy, hydrotherapy and lymphatic drainage massage on the neuromuscular system and hemodynamics of the lower limbs of female field hockey players during training in middle altitude conditions.

Methods and organization. The study was conducted in the Center of biomedical technologies, FSBI "North-Caucasian Federal Research and Clinical Center of the Federal Medical and Biological Agency", at an altitude of 1240 m (Maloe Sedlo Mountain, Kislovodsk) during training camps in the FSUE "Yug sport". It involved 19 female field hockey players aged 16-31 years (Candidate for Master of Sports, Master of Sports titles), members of the Russian national team. All athletes had diagnosis of the functional state of the neuromuscular system and hemodynamics of the lower

limbs. The lower limb hemodynamics were studied with the rheograph (Rheograph Valenta, made by "Kompania Neo" LLC in Saint Petersburg). The Neuro-MVP 4-channel hardware and software complex was used for stimulation electroneuromyography ("Neurosoft", Ivanovo). We have also examined registration of motor responses (M-responses) from the extensor digitorum brevis muscle innervated by the peroneus nerve.

The athletes were divided into two groups – the treatment group and the control group, the divide was randomized. In the course of 7 days, the treatment group received a set of physical therapy procedures, including magnet therapy, hydrotherapy and lymphatic drainage massage (pressure therapy). The control group did not receive any procedures.

Magnet therapy was made with the Physiomed Mag-Expert device, 60 cm coil, impact area – knee and ankle joints, impact time – 15 minutes, magnetic flux density – 0.006 T, frequency – 25 Hz. Beka hospitec, the contrast 4-chamber bath for hands and feet, was used for hydrotherapy, time – 10 minutes, hot water temperature – 38 °C, cold water temperature – 14 °C, cyclicity – 45 s, flow – 220 l/min, pressure – 1 atm. For pressure therapy, we have used the BTL-6000 LYMPHASTIM 12 4-channel device in Physiological mode (physical therapy), procedure area – lower limbs, time – 30 minutes, cuff pressure – 60 mm of Hg.

After the course, both groups had diagnosis of the functional state of the neuromuscular system and hemodynamics of the lower limbs.

The statistical data processing was made with the Wilcoxon matched pair test and the Mann-Whitney U-test on the Statistica 6.0 software. The difference between values deemed significant if $p<0.05$.

Results and discussion. The results obtained from the analysis of the neuromuscular transmission at the beginning did not demonstrate statistically significant differences between groups. The similar data was received after the hemodynamic indicators analysis.

According to the results obtained after the physical therapy course, we can note the following. Analysis of the neuromuscular transmission in the treatment group has revealed an increase amplitude of M-response on the left in two stimulation points: head of fibula (before: 6.05±0.57 мV and after: 6.92±0.72 мV, $p\leq0.03$) and popliteal fossa (before: 6.09±0.51 mV, after: 6.99±0.70 mV, $p\leq0.03$). It allows us to make a conclusion about an increase amount of motor units engaged in contraction when stimulating motor nerve fibers with electric current (fig. 1).

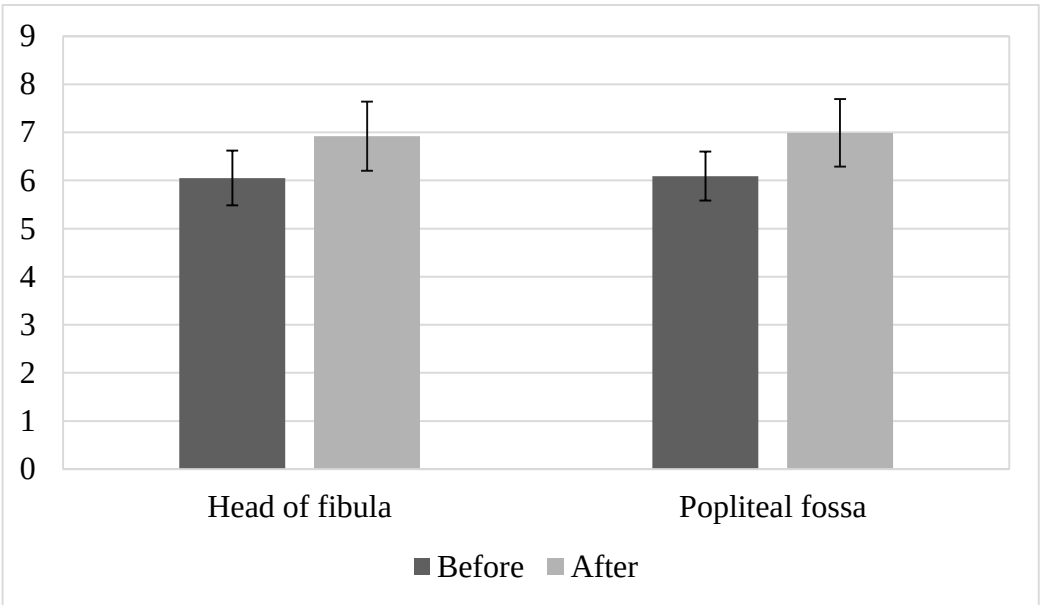

Fig. 1. Indicators of the M-response amplitude in the "head of fibula" and "popliteal fossa" stimulation points on the left in athletes before and after the procedures

The study has not revealed any other significant changes in the neuromuscular transmission in the treatment group. However, we can see that there is a tendency in all stimulation points of the right and left legs to increase following indicators: surface area and amplitude of M-response and nerve conduction velocity (NCV). There was also a decrease in M-response duration and residual latency (table 1).

Table 1

Comparative analysis of motor responses registered from the extensor digitorum brevis muscle, innervated by the peroneus nerve, in field hockey players of the treatment group before and after the procedures

Indicators	Treatment group		p	Standard
	Before	After		
Right tarsus				
Latency, ms	3.33±0.19	3.24±0.14	-	-
Amplitude, mV	6.12±0,51	6.35±0.53	-	≥3.5 mV
Surface area, mV×ms	19.1±1.55	20.6±1.71	-	-
Residual latency, ms	2.31±0.19	2.19±0.14	-	≤3 ms
Right head of fibula				
Latency, ms	10.1±0.34	9.97±0.31	-	-
Right popliteal fossa				
Surface area, mV×ms	19.7±1.70	20.3±1.38	-	-
Left tarsus				
Amplitude, mV	6.52±0.58	7.10±0.64	-	≥3.5 mV
Duration, ms	6.32±0.25	6.25±0.28	-	-
Surface area, mV×ms	20.8±1.43	22.6±1.72	-	-
Left head of fibula				
Surface area, mV×ms	20.3±1.62	23.0±1.92	-	-
Left popliteal fossa				
Duration, ms	6.59±0.30	6.55±0.31	-	-
Surface area, mV×ms	20.6±1.46	23,1±1,89	-	-
NCV, m/s	59.5±2.29	62.9±2.28	-	≥40 m/s

We can conclude that using physical therapy procedures on athletes of the treatment group has contributed to a higher engagement of motor units during the nerve stimulation, consequently – to an increase in muscle contraction surface area, as well to an increase of nerve conduction velocity, which is important for effective performance of movements requiring maximum muscle activation in a short period of time and for muscle coordination improvement.

When analyzing hemodynamic indicators of the treatment group, we have revealed a significant decrease in the asymmetry coefficient in the "foot" segment on the left (before: 47.9±5.79%, after: 23.0±4.52%, p≤0.003) and right (before: 47.9±5.79%, after: 30.4±8.90%, p≤0.04) (fig. 2).According to the microcirculation indicators, we have found decreased parameters of the diastolic index (before: 0.50±0.02 c.u., after: 0.41±0.03 c.u., p≤0.03) in the "calf" segment on the right. In the same segment on the left the aforementioned indicator has a tendency to decrease (before: 0.48±0.04 c.u., after: 0.44±0.03 c.u.) (fig. 3).

The "calf" segment has also demonstrated a significant decrease in the left ventricle filling pressure on the right (before: 24.3±0.52 mm of Hg, after: 21.8±0.76 mm of Hg, p≤0.02). There were no changes on the right, but there was a tendency for its decrease (before: 24.2±0.79 mm of Hg, after: 22.7±0.94 mm of Hg) (fig. 4).

In general, for hemodynamics of the lower limbs, a tendency to decrease in such indicators

as elastic modulus, diastolic index, left ventricle filling pressure was revealed. The indicators of venous outflow and the asymmetry coefficient decreased, which brought them closer to the standard values. However, no significant changes were detected for the listed indicators in the treatment group before and after the procedures (table 2).

Therefore, athletes of the treatment group have higher artery elasticity and normalized venous outflow, which indicates improved microcirculation.

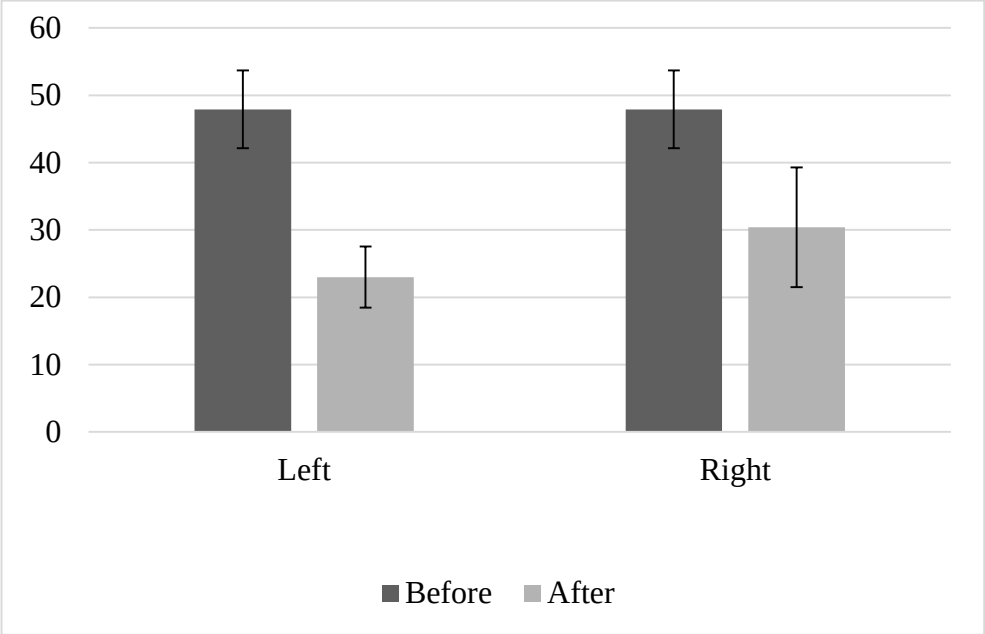

Fig. 2. The blood flow asymmetry coefficient indicators in the “foot” segment of the left and right legs in athletes before and after the procedures

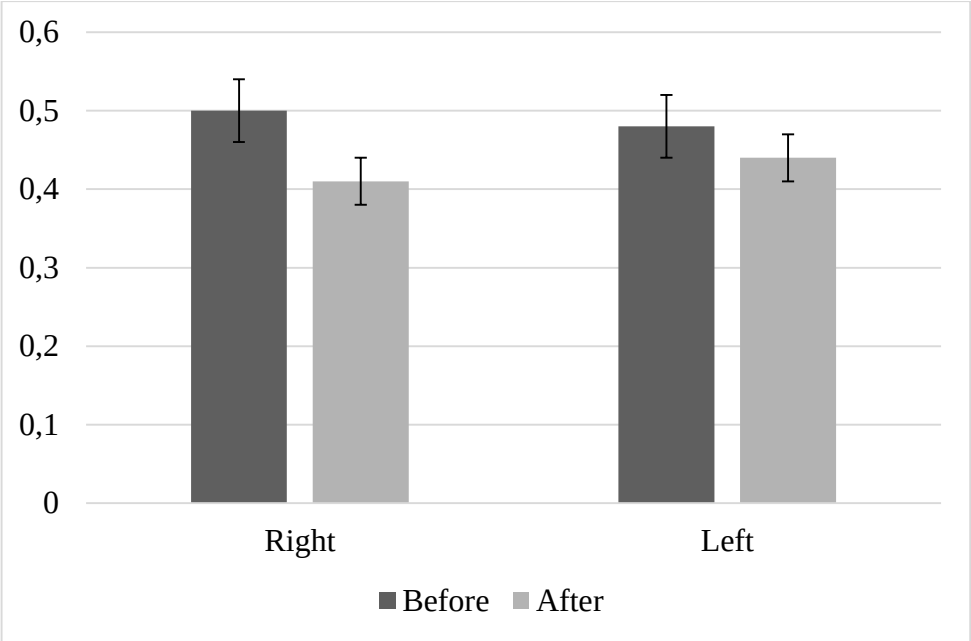

Fig. 3. The blood flow diastolic index indicators in the “calf” segment of the right and left legs in athletes before and after the procedures

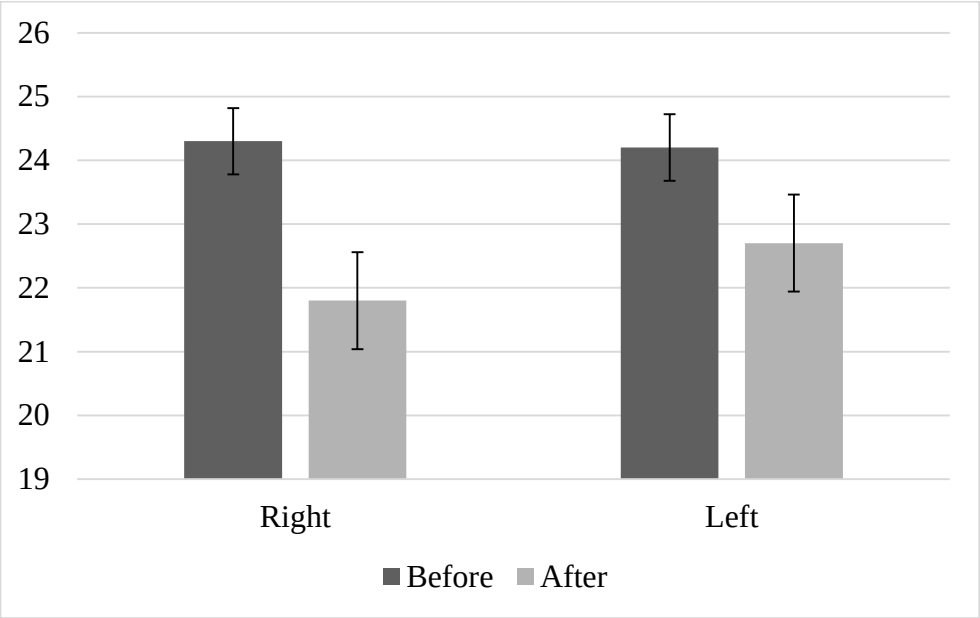

Fig. 4. Left ventricle filling pressure indicators in blood flow of the "calf" segment of the right and left legs in athletes before and after the procedures

Table 2

Comparative analysis of the lower limb rheovasography of female field hockey players before and after the procedures

Indicators	Treatment group		p	Standard
	Before	After		
Left foot				
Elastic modulus, %	15.6±1.71	13.9±1.09	-	11-16%
Diastolic index, c.u.	0.45±0.03	0.41±0.04	-	0.30-0.55
Left ventricle filling pressure, mm of Hg	23.0±0.89	21.7±0.98	-	-
Right foot				
Venous outflow, %	38.5±10.4	22.5±2.83	-	0-20%
Diastolic index, c.u.	0.43±0.03	0.39±0.02	-	0.30-0.55
Left ventricle filling pressure, mm of Hg	22.5±0.93	21.4±0.68	-	-
Left calf				
Diastolic index, c.u.	0.48±0.04	0.44±0.03	-	0.45-0.75
Asymmetry coefficient, %	22.2±4.25	14.8±2.97	-	0-20%
Left ventricle filling pressure, mm of Hg	24.2±0.79	22.7±0.94	-	-
Right calf				
Venous outflow, %	26.3±3.20	23.2±2.54	-	0-20%
Asymmetry coefficient, %	22.5±4.23	14.8±2.97	-	0-20%

Considering the fact that athletes of the main group have received the 7-day physical therapy procedure set, a tendency to normalize the peripheral blood flow indicators and improve the neuromuscular transmission parameters without any statistically significant changes can be explained by a need to receive a course cycle of physical therapy procedures during

training in middle altitude conditions. Thus, further studies are needed with subsequent observation of the functional state of the neuromuscular system and hemodynamics of the lower limbs of athletes.

Conclusion. The analysis of the data received has shown that using the physical therapy set that includes magnet therapy, hydrotherapy and lymphatic drainage massage (pressure therapy)) in the course of 7 days gave a positive effect on the blood flow and the neuromuscular system of female field hockey players during training in middle altitude. Indicators of the peripheral blood flow have returned to normal and the neuromuscular transmission parameters have improved.

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INFORMATION ABOUT THE AUTHORS:

Yulia Valerievna Kushnareva – Candidate of Biological Sciences, Senior Researcher of the Center of Biomedical Technologies, FSBI "North-Caucasian Federal Research-Clinical Center of the FMBA of Russia", Essentuki, e-mail: u.v.kushnareva@skfmba.ru.
Sabina Malikovna Abutalimova – Researcher of the Center of Biomedical Technologies, FSBI "North-Caucasian Federal Research-Clinical Center of the FMBA of Russia", Essentuki, e-mail: sabina190989@yandex.ru.
Oxana Nikolaevna Akimkina – Scientific and Technical Information Expert of the Center of Biomedical Technologies, FSBI "North-Caucasian Federal Research-Clinical Center of the FMBA of Russia", Essentuki, e-mail: randomrecords@yandex.ru.

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