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INFLUENCE OF MILLIMETER ELECTROMAGNETIC WAVES ON THE FUNCTIONAL CAPABILITIES OF THE LOWER LIMB MUSCLES IN ATHLETES - VOLLEYBALL PLAYERS

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Abstract

The authors, when observing 22 athletes - volleyball players of different volleyball specialization, assessed the effect of millimeter electromagnetic waves (EMW) on the functional state of the muscular system of the lower extremities. The electromagnetic effect was carried out using the "Complex SP 80" apparatus (frequencies 3900 - 4120 kHz were used). Electrodes were applied to the muscles of the thigh and lower leg, sinusoidal discharges were applied for 10 seconds during the strength training period. The results of observations showed that under the influence of EME, the height of the jump increases by 7%, due to the increase in the energy of the jump and its intensity. The release of the activity of the knee joint is also noted. The authors believe that under the influence of EME, the transmission of regulatory impulses in neuromuscular contact improves, which contributes to the synchronization and strength of contractions of the muscle fiber bundles. Also, under the influence of EMW, blood microcirculation in the muscle improves.

Key words: jump parameters; electromagnetic waves; muscle functionality.

Introduction. Volleyball today is one of the most popular and widespread sports [1 - 4]. From the point of view of physiology, volleyball refers to acyclic muscular loads, which have a predominantly speed-power and precise-coordination character. Motor activity during the game consists of many lightning starts and accelerations, jumps up to both maximum and optimal heights, explosive strikes with maximum muscle strength [5, 6]. All these actions take place with an almost continuous long-term response to a changing environment. All of the above makes high demands on the training of athletes [7 - 10].

An important component of the physical training of volleyball athletes is the training and development of jumping ability. Jumping ability is determined by the ability of the neuromuscular apparatus for the high-speed manifestation of maximum effort [11, 12]. The biomechanics of a jump consists of two main phases - the amortization phase and the active repulsion phase. The first phase is characterized by a shift in the center of gravity and the fulcrum, with a simultaneous flexion angle of the knee joint up to 110-120 degrees, the muscles work in this phase gradually. The phase of active repulsion is characterized by the separation of the center of gravity from the support. Muscle work in this phase is explosive in order to give maximum speed to the body and to overcome the force of gravity of the knee joint while unbending to 160-170 degrees [13, 14, 15].

The final part of the jump - landing, is characterized by the gradual work of the muscles aimed at damping the speed of the body falling, and by the tension of the ligamentous apparatus to prevent the displacement of parts of the bone skeleton in relation to each other.

To develop the functional capabilities of the musculoskeletal system, volleyball players use special physical training, which contributes to the development of special physical qualities. The successful application of the methods of this training requires the development and implementation of physiotherapeutic techniques into the training process of volleyball players - supporting the physiological mechanisms of the musculoskeletal system and / or correcting possible current failures in its activity.

The purpose of the work is to substantiate the possibility of using millimeter electromagnetic waves to improve the quality and efficiency of the functional capabilities of the muscular system of the lower extremities of volleyball players.

Materials and research methods. The material of the work was the data obtained when working with 22 volleyball players of the volleyball club "Polytechnic", Odessa, Ukraine, in the period 2018 - 2019. The work involved male volleyball players of different game specialization at the age of (25 ± 3) years.

The research was carried out in two mesocycles of 11 workouts.

The first cycle included jumps on straight legs with a tense ankle with extensive plyometric work of a large volume. The training regimen was as follows:

1 - 3 days: work / rest 6 sec / 20 sec - 6-8 jumps per circle (20 laps).

4 - 11 days: work / rest 6 sec / 24 sec - 6-8 jumps per circle (16 laps).

The second cycle consisted of 8 workouts, 4 weeks of 2 workouts. Athletes performed a Pancake Hook Squat (GAC) against a wall above parallel with toe exiting (explosive performance). Training mode: work / rest - 6 sec / 24 sec. The load on all days was the same - 10 sets, 4 - 5 squats with an exit.

The functional capabilities of the thigh muscles were corrected using the "Complex SP 80" apparatus. For this, electrodes were applied to the area of the quadriceps, thigh and gluteal muscles and sequential sinusoidal signals with a frequency of 4000-4120 kHz and 3900-4000 kHz were applied, the duration of the signals was 3 s and 10 s, respectively. The total duration of the session corresponded to the duration of the microcycle, but did not exceed 10 minutes. With daily training sessions of EMV exposure were carried out every other day, the total duration of the course was 5 sessions.

The results of the method used were evaluated according to the following indicators:

- a subjective assessment of the condition of the muscles and the activity of the knee joint according to the feelings of the study participants before the start of the morning workout;

- jump height;

- the nature of the landing;

- energy indicators of the jump;

- functionality of the knee joint (gonometry).

The data obtained were processed by the methods of variation statistics. Due to large individual deviations of values, the significance of differences was assessed using the G-test of signs.

Results and its discussion.

The examination of the state of the muscular system of the lower extremities began with a subjective assessment of the state of the study participants before the start of morning

training. According to the data obtained, 63.6% of the players noted stiffness in muscle activity and discomfort in the knee joint area. At the same time, in some cases, for the successful use of muscles, it was required to warm them up with light massage movements. As a result of training mesocycles, there was a significant increase in the circumference of the lower leg: left - (1.3 ± 0.07) sm, right - (1.5 ± 0.09) sm, ($p < 0.05$). After the course of correction with the use of EMW, positive changes are noted in the state of the lower extremities. According to the subjective assessments of the study participants, the stiffness of the knee joint and discomfort in the muscles of the lower extremities persisted in 17.1% of the participants before the start of the morning workout. At the same time, they noted that muscle discomfort goes away on its own and massage movements are not required to eliminate it.

According to gonometry data (Table 1), flexion of the knee joint practically did not change, while the possibilities of extension significantly increased ($p < 0.01$). Perhaps this is due to a slight increase in the elasticity of muscles and ligamentous apparatus as a result of the corrective effect of EME.

Table 1 Characteristic of the influence of millimeter electromagnetic waves on the indicators of the functional capabilities of the lower extremities

Indicators	Groups					
	Reference meaning		Before the EMV course		After the EMV course	
	bend.	extension	bend	extension	bend	extension
Gonometry, degrees °	40,0±1,3	160,0±0,48	42,0±2,3	147,15±2,13	43,3±3,01	157,10±3,70**
Jump height, sm	50 - 60		51,40 ± 5,2		55,39 ± 7,7*	
Empty landings, %	Soft		93,67 ± 0,21		93,68 ± 0,22	
	high strength		3,77 ± 0,27		4,32 ± 0,26	
	"emergency"		2,56 ± 0,15		2,0 ± 0,17*	
Jump energy, J	1907 — 2067		2285 ± 22,0		2488,75 ± 24,7***	
Jump intensity, W / kg	1— 10		36,57 ± 3,4		40,26 ± 5,1	

Note. Significance of differences between indicators before and after the computer course: * - $p < 0,05$; ** - $p < 0,01$; *** - $p < 0,001$

As a result of these changes, there was a significant improvement in jump performance. First of all, the average jump height increased by 7.75% ($p < 0.05$). Moreover, it

should be noted that an increase in the height of the jump took place among volleyball players of different volleyball specializations - not only among the forwards, but also among the setters. As a result, the jump energy increased significantly ($p < 0.001$). At the same time, the intensity of the jump practically did not differ from that before the course of the EMW exposure ($p > 0.05$). Obviously, this indicator is more connected with the achievements of the entire training process, and not with momentary improvements in the functional capabilities of the muscles.

As for the final phase of the jump - landing, according to the data in Table 1, soft landing in frequency remains at the level before the course of EME correction. At the same time, the number of landings with high strength has a steady tendency to increase, although without statistical significance ($p > 0.05$). The most interesting is the significant decrease in the number of "emergency" landings ($p < 0.05$). Obviously, an increase in the functional capabilities of the soft tissues of the lower extremities increases the damping effect, eliminating the deforming load of the ligamentous apparatus of the foot, and, thereby, reduces the likelihood of injury.

Conclusions

Thus, the results of the above study showed that the use of EMW in the training process among volleyball players has a significant positive effect. First of all, it manifests itself in the elimination of negative subjective components, such as morning discomfort in the muscles of the lower extremities and knee joint. The impact of EME improves the functionality of the muscular apparatus of the lower extremities, which leads to an increase in the height of the jump, an increase in its energy, and the prevention of possible sports injuries. Based on the results obtained, the EMW technique can be recommended for implementation in the training process among volleyball players of all specializations.

References

1. Britannica, The Editors of Encyclopaedia. "volleyball". Encyclopedia Britannica, 2021, 23 May. <https://www.britannica.com/sports/volleyball>.
2. Belyaev AV, Bulykina LV. Volleyball: theory and training methodology. Moscow: TVT Division, 2011: 753 p. [in Russian].
3. Volleyball. Sports encyclopedia. Moscow: Eksmo, 2013: 407 p. [in Russian].
4. Kleshev YUN, Volleyball. Moscow: Media, 2017: 593 p. [in Russian].
5. Zahradnik D, Jandacka D, Holcapek M, Farana R, Uchytel J, Hamill JJ. Blocking landing techniques in volleyball and the possible association with anterior cruciate ligament injury. Sports Sci. 2018 Apr;36(8):955-961.

6. Calleja-Gonzalez J, Mielgo-Ayuso J, Sanchez-Ureña B, Ostojic SM, Terrados N. Recovery in volleyball. *J Sports Med Phys Fitness*. 2019 Jun;59(6):982-993. DOI: 10.23736/S0022-4707.18.08929-6.
7. Lidor R, Ziv G. Physical and physiological attributes of female volleyball players -a review. *J Strength Cond Res*. 2010 Jul;24(7):1963-73. DOI: 10.1519/JSC.0b013e3181ddf835.
8. Markov KK. Modern volleyball technique: monography. Krasnoyarsk: Siberian Federal University. 2013: 220 p. [in Russian]. <https://bik.sfu-kras.ru/shop/publication?id=BOOK1-75/%D0%9C%20268-762358>
9. Skazalski C, Whiteley R, Bahr R. High jump demands in professional volleyball-large variability exists between players and player positions. *Scand J Med Sci Sports*. 2018 Nov;28(11):2293-2298. DOI: 10.1111/sms.13255.
10. F. Stibitz Volleyball. Moscow: Media, 2017: 790 p. [in Russian].
11. Freitas-Junior C, Gantois P, Fortes L, Correia G, Paes P. Effects of the improvement in vertical jump and repeated jumping ability on male volleyball athletes' internal load during a season. *Journal of Physical Education and Sport (JPES)*. 2020;20(5), Art 397:2924-2931. DOI:10.7752/jpes.2020.s5397.
12. Trajković N, Bogataj Š. Effects of Neuromuscular Training on Motor Competence and Physical Performance in Young Female Volleyball Players. *Int J Environ Res Public Health*. 2020;17(5):755. DOI:10.3390/ijerph17051755.
13. Jordanian FA. Functional readiness of volleyball players: diagnostics, adaptation mechanisms, correction of dysadaptation symptoms. Moscow: Sport, 2016.176 p. <http://www.sportkniga.kiev.ua/product/2532/1.html>. [in Russian].
14. Junior CDeAC, Bastos CL, Suzuki FS. Biomechanical and kinesiological analysis of the jump movement and landing in the volleyball slash. *South Florida Journal of Development, Miami*. 2021;2(2):2252-2261. DOI: 10.46932/sfjdv2n2-088.
15. Moran KA, Wallace ES. Eccentric loading and range of knee joint motion effects on performance enhancement in vertical jumping. *Hum Mov Sci*. 2007 Dec;26(6):824-40. doi: 10.1016/j.humov.2007.05.001.