

Effect of Vibrostimulation on Athletes' Performance

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The traditional ways of improving the physical fitness of athletes through the use of training are widely known. However, in recent years the so-called nontraditional methods have become increasingly popular. These include electrostimulation, acupuncture, acupressure, vibrostimulation of active points, and so forth. The purpose of this paper is to study the effect of single vibrostimulation of biologically active points on the improvement of athletic performance. As a criterion of efficiency of vibroaction a PWC_{170} test was used; spectral characteristics of the tremor of upper extremities were studied, and the time shown by the athletes on the 100-m swimming distance was recorded.

Methods

Fifty trained swimmers (30 men, 20 women) aged 17 to 22 years were monitored. The duration of the experiment was 2 days.

On the first and second days the swimmers swam 100-m freestyle at maximum speed. The parameters of arm tremor were determined before the load and immediately after the finish. The individuals under monitoring took an upright stance with feet apart at shoulders' width, arms forward, palms down, and eyes open. An acceleration transducer (accelerometer) weighing 0.3 g was attached to the distal phalanx of the middle finger of the dominating arm. The tremogram was recorded on a measuring tape recorder with subsequent application of the analog signal to the input of a narrowband frequency analyzer (Bruel & Kjaer) interfaced to a personal computer (Hewlett-Packard). The tremogram recording took 1 min.

The spectral data determined in the process of frequency analysis were subjected to averaging in order to reduce the effects of random variations and hence to increase statistical reliability of the results of analysis. Linear averaging gave true rms values in individual narrow-frequency bands.

In this paper we give spectrum-averaging data for frequency bands from 1.25 to 20 Hz obtained from 10 to 35 s of recording for 64 instantaneous spectra. We also used an indicator that reflects the energy of time signal of the tremogram (W) obtained from 25 to 35 s.

Table 1 Means and Standard Deviations of Athletes' Performance Indicators Under the Action of Vibrostimulation

Measurement	Men	Women
Average time of swimming a 100-m distance (in s) without vibrostimulation	72.14 ± 0.37	78.65 ± 0.55
Average time of swimming a 100-m distance (in s) with vibrostimulation	68.27 ± 0.39	75.15 ± 0.51
PWC_{170} (in m/s) without vibrostimulation	1.08 ± 0.01	1.01 ± 0.02
PWC_{170} (in m/s) with vibrostimulation	1.12 ± 0.02	1.06 ± 0.01

Physical performance as expressed in terms of speed of covering standard lengths of the distance (in m/s) with a pulse of 170 was determined according to the method of Belotserkovsky (1980). The test was performed after taking the tremogram before the start of the 100-m swim.

On the second day of the experiment, after a background tremogram was taken, vibrostimulation was performed by two-point vibratory massage devices simultaneously acting on six pairs of symmetrically located, biologically active points in the following sequence: GJ-4, E-36, Tr-15, G-14, V-17, V-13 (according to the European classification, Bossy, 1982).

We used a conical vibrotode with a point area of 4 mm² and an edge radius of 1 mm; the vibration frequency was 120 Hz and the amplitude 3 mm. The duration of action on each point was 30 to 35 s. The overall duration of vibroaction was 3 to 3.5 min. The conditions of action and the sequence of points were selected in the experimental way.

Results

The study has shown that the use of the proposed mode of vibrostimulation contributes to the improvement of athletic performance. Positive effects of vibration have been detected in 96% of the cases. During the procedure some individuals felt pricking in the points acted upon, whereas after the termination of the procedure they had a sensation of warmth.

Objectively, markedly better results at free-style swimming of a 100-m distance were shown, and a somewhat higher speed of executing the specialized PWC_{170} test by both men and women was observed (Table 1).

The tremor parameters after the load showed unidirectional change both in men and in women. The time signal energy (W), which actually reflects the surface area of the tremogram on the first day, increased in the female group on the average from 0.18 V²s in the initial condition to 0.38 V²s after the finish. For the male group the increase in this indicator was from 0.41 to 0.87 V²s. On the second day of the experiment, when before swim-

Table 2 Changes of rms Levels in Frequency Bands of the Spectrum of Tremogram in mV

	Frequency band (Hz)											
	2.5	3.75	5	6.25	7.5	8.75	10	11.25	12.5	15	17.5	20
Women												
Initial level	60	53	50	55	66	60	47	34	28	21	17	13
After 100-m Day 1	113	93	90	104	95	64	46	37	33	28	19	17
Initial level	56	44	43	61	65	54	37	26	20	18	14	11
After 100-m Day 2	74	77	80	85	67	50	38	28	26	29	17	14
Men												
Initial level	60	52	55	88	120	112	77	56	43	33	27	23
After 100-m Day 1	108	108	125	150	160	147	110	74	52	40	30	25
Initial level	87	66	67	87	108	104	88	76	54	38	30	26
After 100-m Day 2	97	90	94	108	123	100	70	50	42	36	33	26

ming a 100-m distance vibrostimulation was applied, the increase in this indicator was less pronounced (for women from 0.13 to 0.25; for men from 0.35 to 0.54 V's). The change in the integral indicator used—the averaged spectrum in the given frequency band—took place in a similar manner. The physical load without the application of vibrostimulation caused both in men and women the increase of rms levels in the frequency bands of the spectrum shown (Table 2). The application of vibroaction produced a normalizing effect and reduced the absolute values of the given indicator as determined after the finish. The most pronounced differences were observed in frequency bands 1.25 to 7.5 Hz for women and 1.25 to 11.25 for men. We must note also the decrease of the averaged spectrum of the tremogram below the initial level in the male group in frequency bands from 10.0 to 13.75 Hz.

Discussion

Mechanical vibration on reflexogenous zones causes a general adaptive reaction. Functional alterations caused by the given physical factor when acting in adequate dosages obviously are stimulating the neuromuscular, cardiovascular, and endocrine systems' activity.

The action of point vibration is based to a considerable extent on the response reaction of the neuromuscular system (Manaka, 1973). Here it is important to determine the optimal mode of vibroaction (the frequency, amplitude, duration, and geometric shape of the vibrotode and the direction and angle at which the action proceeds) and, of course, the most effective combination of biologically active points.

Obviously, vibratory action stimulates the work of motor units of the muscles at the expense of "forcing" an appropriate rhythm of activity and increasing the energy of biochemical and bioelectrical processes. The

rhythmical nature of point vibratory action evidently evokes its biological activity and a multiplicity of response reactions from athletes' bodies at different levels of the nervous and endocrine systems. The physiological mechanism of such an action requires further study.

References

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The Influence of Foot Position on Knee Joint Kinematics During Cycling

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The activity of bicycling has been investigated by numerous experimenters to establish efficient and optimal riding styles. Electromyographic studies have revealed the patterns of muscular activity. Jorge and Hull (1984) studied eight muscles during cycling to establish the sequence of activity. Tate and Sherman (1977) demonstrated that the use of toe clips increases efficiency and activates the use of the flexor muscle groups. The seat height has also been shown to influence the cycling activity. A higher seat height was shown to require less muscular effort (Houtz & Fischer, 1959), and the major adjustment to an increase or decrease of the seat height was shown to occur in the knee and ankle joints (Nordeen-Snyder, 1977). Other investigators have focused on the measurement of pedal loads under varying conditions. Using a six-load component pedal dynamometer, Davis and Hull (1982) reported maximum pedal loading at 90 to 110° in the cycle. Their analysis suggests that as the cyclist applies a force through this maximum loading period the foot pushes outward and the heel twists outward. A 3° adjustment of the foot placement for 1 subject was shown to alter the load profile by increasing the vertical moment with a negative angular adjustment and decreasing the moment with a positive angular adjustment. Comparisons made among three foot pedal connections revealed the cleated toe-clip condition to be the most efficient by providing for greater hamstring and plantar flexion control in the cycle.

Information on three-dimensional knee joint movement parameters during cycling is lacking. There is ample evidence provided by electrogoniometric studies collected during running or walking (Frankel & Nordin, 1984; Kettlecamp, Johnson, Smidt, Chao, & Walker, 1970; Knutzen, Bates, & Hamill, 1983). The description of the knee joint kinematic parameters during cycling could be helpful in the evaluation of knee injury to cyclists. Bohlmann (1981) cites knee injury as a significant problem with competitive cyclists and suggests that knee problems may be related to improper seat height or improper foot position on the pedal. The purpose of the present study is to examine knee joint movement parameters under three different foot positions.