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Original Article

Study of the rowing technique major components

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Abstract:
The aim of the work: determining the major characteristics of the rowing technique motor structure. *Material and methods*. Twenty rowers (first-class athletes) specialized in sculling participated in studies. Athletes covered 200 m distance and the control 500 m segment at different speed and pace. *Results.* The most important index of the rowing technique at any pace is the impulse of force of water pressure on the oar blade (kg·s-1). Correlation coefficients constitute: at a pace of 22-24 strokes·min-1 − r=0,93 (at P<0,001), at a pace of 28-30 strokes·min-1 − r=0,96 (at P<0,001) and at a pace of 34-35 strokes·min-1 − r=0,83 (at P<0,001). Achievement of high result necessitates the development in athletes of the ability to maintain high impulse of force for the speed (close to distance) of the boat. In addition, this characteristic should be developed under conditions of muscle fatigue, competitive excitement, in high winds, high seas, etc. Acceleration of the general center of gravity of rower’s body at the approach has a positive impact on sports result at any pace of rowing. *Conclusions*. The impulse of force of water pressure on the oar blade represents the main component of the rowing technique efficiency. The way of the boat steadiness is the second criterion of the rowing technique efficiency, whereas the acceleration of the general center of gravity of rower’s body at the approach constitutes the third component of the rowing technique efficiency.
Key words: rowing, biomechanical indices, technique, major components

Introduction

At the present time, the most significant increase of results in the majority of sports events is related to the improvement of athlete technical fitness. Questions dealing with determining the motor activity peculiarities of those engaged in various sports events and rowing, in particular, are becoming more urgent.

The main motion of the “boat-rower-oar” system is the stroke performed by oar. It creates support for the blade in the water allowing forward motion of the boat. That is why, the problem of the boat speed increase holds central stage among numerous authors (Fleming at al., 2007, Kolumbet, 2017, Kvashuk at al., 2016, Molland at al., 2011, Verlin at al., 2014).

The modern process of technical fitness improvement is based on the management theory, which necessitates the study of motions and quantitative and qualitative description of the major components of athlete motor activity (Hosea & Hannafin, 2012, Kvashuk at al., 2015, McDonnell at al., 2012, Yun Loi Lok, 2013).

Kinematic characteristics in rowing are considered secondary (Kemecsey, 1986, Kolumbet at al., 2017, Verlin at al., 2015). Most researchers believe that the dynamic characteristics are the main indices of the technique (Kvashuk at al., 2015, Michael at al., 2012, Włodzimierz Chodinow & Marcin Kaca, 2010). It is difficult to measure the dynamic characteristics in practice. The direct impact on the dynamic indices of an athlete is extremely complex.

The study of kinematic characteristics (management of which allows changing the dynamics of rowing) is very promising.

Hypothesis - the study of kinematic characteristics influence on sports result will improve both the technique of rowing and the result itself.

Objective − determining the major characteristics of the rowing technique motor structure.

Materials and methods

Subjects. Twenty rowers (first-class athletes) specialized in sculling participated in studies. Athletes covered 200 m distance and the control 500 m segment at different speed and pace.

Organization of study. Peculiarities of the coordination structure of rowers’ movements were studied in a natural and laboratory experiment.

A complex method for carrying out biomechanical studies was used. The dynamics of the kinematic and dynamic characteristics of efforts applied by the rower to the oar and the pressure on the canoe seat, the

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goniogram of the trunk work, the accelerograms of wrist motions in lateral and vertical axes, the instantaneous speed of the boat, and the peculiarities of bioelectrical activity of the muscles of the trunk, arms, back and abdomen were studied. During analysis of electromyograms, the amplitude and frequency of biopotential oscillations, the rhythmic structure of bioelectrical activity, integrated bioelectrical activity of muscles were determined both in absolute and in relative terms. Besides, the indices of efficiency and economy of motor activity were calculated, the variability of studied characteristics of motions was determined (Monogarov & Bratkovsky, 1979).

Statistical analysis. While processing the experimental data, we determined the average values of the indices and their errors (X ± m), the degree of difference in the means and the significance of differences (t, p), the dispersion value around the mean (σ, CV), and the degree of interrelation between the studied indices (r).

While conducting complex pedagogical, biomechanical and biological examinations with participation of athletes, we adhered to the legislation of Ukraine on health protection, the Helsinki Declaration of 2000, the Directive No. 86/609 of the European Society on the participation of people in biomedical researches.

Results and analysis

At the pace of rowing equal to 22-24 strokes per minute the greatest impact is caused by the time of trunk return from the rear position (r=0,51, P<0,001, Table 1). At such a pace the athletes of the given skill level remain in the rearmost position for quite a long period resulting in loaded bow. Average cyclic water resistance tends to increase. Delay of oars in the final position causes additional blade braking against the water.

The next most important characteristic is the *time of trunk extension* (r = -0.44, P <0.01). This kinematic characteristic has a direct influence on the velocity of oar motion. It affects the interaction of the rowing mechanical system with the external environment.

The influence of trunk motion amplitude on sports result (r=0,40, P<0,001) is explained by relatively significant changes in the speed of the rowing mechanical system. The amount of efforts applied by the rower to the rubber hand grips is greater than that at the higher pace of 32-34 strokes·min^{-1}. This dependence tends to disappear when the pace of rowing is increased. The above is confirmed by decreased impact of maximal effort on the result when the pace of rowing and speed of the boat are increased.

Proper rhythm maintenance is of tremendous importance. This is shown by appearance of dependence between sports result and the ratio of time of trunk extension to that of working phase at high rowing pace (r=0,63, P<0,001). In addition, the dependence between sports result and the time of rower's being in the main position tends to occur (r=0,61, P<0,001).

Table 1. Correlations between kinematic and dynamic characteristics and sports result at various rowing pace

Characteristics	22-24 strokes per minute	28-30 strokes per minute	32-35 strokes per minute
Impulse of blade interaction with water, kg·s^{-1}	0,93	–	–
Average cyclic effort, kg	0,88	0,80	0,92
Maximal speed of boat in the cycle, m·s^{-1}	0,59	0,91	0,70
Trunk return from rearmost position, s	– 0,59	– 0,62	–
Maintaining average effort on blade, s	– 0,64	–	–
Maximal effort on blade, kg	0,50	–	–
Impulse of blade interaction with water, kg·s^{-1}	–	0,83	0,96
Minimal speed of boat in the cycle, m·s^{-1}	–	0,75	0,69
Average speed of boat in the cycle, m·s^{-1}	–	0,92	–
Acceleration of rower's general center of mass, m·(s^{-1})^2	–	0,70	–
Ratio of trunk extension to working phase, %	–	0,63	–
Time of airborne phase, s	–	– 0,61	–
Time of being in the initial position, s	–	0,61	–
Rowing pace, strokes·minute^{-1}	–	0,60	–

The impulse of force of water pressure on the blade is the most significant index of rowing technique at any pace (kg·s^{-1}). Correlation coefficients constitute: at a pace of 22-24 strokes·min^{-1} − r=0,93 (P<0,001), at a pace of 28-30 strokes·min^{-1} − r=0,96 (P<0,001) and at a pace of 34-35 strokes·min^{-1} − r=0,83 (P<0,001).

Discussion

Achievement of high result necessitates the development in athletes of the ability to maintain high impulse of force for the speed (close to distance) of the boat. Moreover, this characteristic should be trained under conditions of muscle fatigue, competitive excitement, in high winds, high seas, etc.

Progress in this direction would greatly accelerate the introduction into practice of training of immediate information devices. Information devices enable the athlete to evaluate the impulse of force of water interaction with the blade after each stroke (Kolumbet, 2017, Petrone, 2006).

The impact of maximal effort on sports result tends to decrease along with the increase of rowing pace (Hosea & Hannafin, 2012). Increased speed of the boat results in decreased influence of muscle strength (Bianca Miarka at al., 2018), and increased importance of speed qualities (Begon at al., 2010, Kvashuk at al., 2012). This may be taken into account while bringing the crews up to strength. Rowers with better speed capacities but lower absolute strength should be placed in "faster" boats.

Acceleration of the general center of gravity of rower's body at the approach has a positive impact on sports result at any pace of rowing (Baudouin & Hawkins, 2002, Kvashuk at al., 2016). Importance is being increasingly attached to acceleration of the general center of gravity of rower's body with support on the blade (Verlin at al., 2014). The fact is that at the approach the active interaction of the rowing mechanical system with the external environment is absent. Way of the boat steadiness becomes to play center stage. Forces aimed at rower acceleration at the approach should balance those of water resistance to the boat movement. Therefore, at low pace (when acceleration of the rower at the approach is insignificant) the impact of this characteristic is much higher (Alfonso Penichet-Tomas at al., 2016, Zahra Nili Ahmadabadi at al., 2014). At the moment of oar support in the water (although the acceleration of the general center of gravity of the rower's body increases with deviation of boat speed from the average cyclic), the acceleration of the general center of gravity of the rower's body is advantageous. This results in blade faster finding support in the water. In addition, the impulse of force of water interaction with the blade increases.

Way of the boat steadiness is the main criterion of technique efficiency only during the phase of approach execution. The impulse of force of water pressure on the blade represents the major component of the rowing technique efficiency at the working phase.

Conclusions

The impulse of force of water pressure on the oar blade represents the main component of the rowing technique efficiency.

The way of the boat steadiness is the second criterion of the rowing technique efficiency.

The acceleration of the general center of gravity of rower's body at the approach constitutes the third component of the rowing technique efficiency.

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Conflict of interest

The authors declare no conflict of interest.

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