Electromyographic profile of the vastus lateralis and biceps brachii of sprinter and endurance runners during a maximal aerobic test. Relation with oxygen consumption

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Introduction

Over the last years, the development of studies related with the oxygen consumption and the skeletal muscle ability to produce power has been increasing. However, these studies have been scarce and still contradictory. Some works point to a linear relation between skeletal muscle contraction and oxygen uptake, whereas others indicate a non-linear relationship. The aim of this work was to study the relation between the neuromuscular activity by surface electromyography in the right Biceps brachii and Vastus lateralis muscle and oxygen consumption during a maximal aerobic exercise test.

Methods

Three groups of male volunteers participated in this study: sprint athletes (SA), endurance athletes (EA) and seven sex-matched sedentary controls (SC), all matched in age (SA:22.0±1.5; EA:23.8±2.3; SC:24.1±0.5 years old). Anthropometric measures were made, and the percentage of fat mass was calculated according to the formula described by Peterson et al. (2003) using age, height and four skinfolds thicknesses (triceps, subscapular, suprailiac and midthigh). All subjects performed an aerobic maximal graded exercise test in cycle ergometer (Monark 824E) in order to determine specific VO2max. This test consisted in a constant pedal frequency (60 rpm) starting with 50 W workload and increasing 25 W every two minutes until fatigue. Oxygen and carbon dioxide measurements were made with a Metamax Ergospirometry System. Before the exercise test basal values of heart rate and blood pressure were also measured. The blood pressure was measured using the classic method with a sphygmomanometer. The heart rate was evaluated continuously using a heart rate monitor (Polar®). During the exercise test the surface electromyographic parameters (iEMG and MPF-mean power frequency) were evaluated in the right Biceps brachii and Vastus lateralis of each subject. The EMG recording was made with a MegaWin® ME3000 device. In order to compare individual results the iEMG values were normalized by dividing the obtained values for the crural and bicipital perimeters of each subject. Results were analysed according to power.

Results

Due to the athletes’ self-characteristics, the endurance group showed a decrease in body mass (70.4±2.8 and 79.5±2.7 Kg for EA and control respectively) and in percentage of body fat (15.0±0.5 and 21.5±1.6). Regarding the body mass index and stature no differences were observed between groups. Both athlete groups showed different results when compared to the control group. As far as specific VO2maxis concerned, an increase in both athlete groups was verified but more significantly in the EA then in the SA group (SC:41.98±1.78; SA:55.09±2.72; EA:61.73±2.63 ml.Kg⁻¹.min⁻¹). Regarding the sEMG results we found different profiles in both studied muscles depending on the athletes’ training. When we compared VO2 relationship with amplitude (iEMG) in Biceps brachii we found a linear relation on athletes with aerobic training, whereas for anaerobic athletes (SA) the relationship is parabolic until R=1, and linear after this point (the same behaviour as control). Nevertheless, in both groups there was an increase in amplitude. Concerning Vastus lateralis profile, in all studied groups there was an increase with linear relationship between amplitude and VO2. However, the control group (SC) showed higher amplitude for a lower VO2. Also, the variation of MPF with power showed differences between groups and muscles. In control and EA groups there was a constant decrease in MPF of the Biceps brachii. On the contrary, for the SA group the MPF values were constant until R=1, after which they decreased. The same profile was found for the Vastus lateralis muscle.

Discussion/Conclusions

Our results suggest that the training type changes the relationship between VO2 and the neuromuscular activity. In subjects with aerobic training there was an increase of neuromuscular activity. These athletes also showed, in both studied muscles, a linear relationship between amplitude and VO2, as well as resistance to fatigue. In the athletes with anaerobic training the relation between iEMG and VO2 is linear only after the R=1 was achieved, with a previous hyperbolic relation. In these athletes both muscles (Biceps brachii and Vastus lateralis) reached fatigue in the latter part of the exercise test. This fact may be due to changes in muscle pH that are more intense in anaerobic trained subjects.

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References