INFLUENCE OF AEROBIC AND ANAEROBIC RUNNING WORKLOADS ON MUSCLE ENDURANCE ABILITY

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INTRODUCTION

Different kinds of sports activity (as far as intensity, duration, technical complexity, etc.) are concerned cause not only different gradients (degrees) of decrease in muscular effectiveness (fatigue), but also have different causes of muscle fatigue after different exertion (the influence of central and peripheral mechanisms of fatigue differs if the loads are different); this is based on the data and findings of laboratory research (Bigland-Ritchie, 1978; Davies, 1982; Jones, 1979) in which the characteristics of muscle fatigue were studied on unselected population with loads that presented non-typical sports loads.

In this contribution we would like to present to what extent different cyclic monostructural (running) loads cause a decrease in the endurance ability of the neuromuscular system and what role the central mechanisms of neuromuscular activity play in this decrease in the endurance ability.

METHODS

Test loads

Eight well-trained middle and long-distance runners carried out two different running test loads:

a) an uninterrupted 6 km run at the speed of the anaerobic threshold (V_{OBLA} criterion)

b) interval training in a 5 X 300-metre run at submaximal speed with a one-minute pause in between.

The intensity of both running loads was monitored by measuring the heart rate (HR) and the lactate blood concentration (LA).

The endurance ability and the source of the fatigue of the muscular contractile system were defined by biomechanical parameters of voluntary and electrically induced muscular contraction.

Description of the procedure:

During a maximal isometric contraction of the quadriceps femoris muscle contraction (measured through the torque in the knee joint by means of a suitable splint) that lasted for 25 seconds, the vastus lateralis and vastus medialis muscles were additionally stimulated with three short 0.8-second trains of electrical impulses at the frequency of 100 Hz. Figure 1 show the recording of muscle force.

Three parameters describe the endurance ability of the muscular contractile system:

a) The index of the decrease in voluntary contraction force Fv

$$Fv = (F_{M3} - F_{M2}) \times F_{M2}^{-1} \times 100 \quad \text{(equation 1)}$$

b) The index of the decrease in electrical stimulated contraction force Fs

$$Fs = (F_{A3} - F_{A2}) \times F_{A2}^{-1} \times 100 \quad \text{(equation 2)}$$

c) Contraction force at the end of the 25-second long isometric contraction (F_{M3})

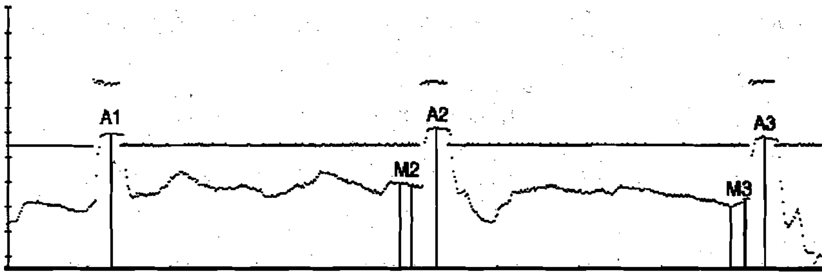

Figure 1: Recording of the muscle force during the 25-second long maximum isometric contraction with an additional periodical electrical stimulation (for symbols see text)

The infleences the central **mechanisams** on muscular fatigue is given by the index of cental fatigue **(I_{CF}) (equation** 3).

$$I_{CF} = Fv - Fs \qquad \text{(equation 3)}$$

Statistical methods

Student's t-test was used to establish the statistical significance of the diferences between results of the individual parameters at different points of measurement.

RESULTS

Biochemical and functional parameters before, during and after the running loads of different types and intensity

The average speed of the **6-kilometre run** amounted to 4.96 **m/s** and speed of interval runs amounted to 6.8 **m/s.** The dynamics of the **heart** rate and the lactate **kinetics** before. during and after the **running** loads are shown in Figures 2.

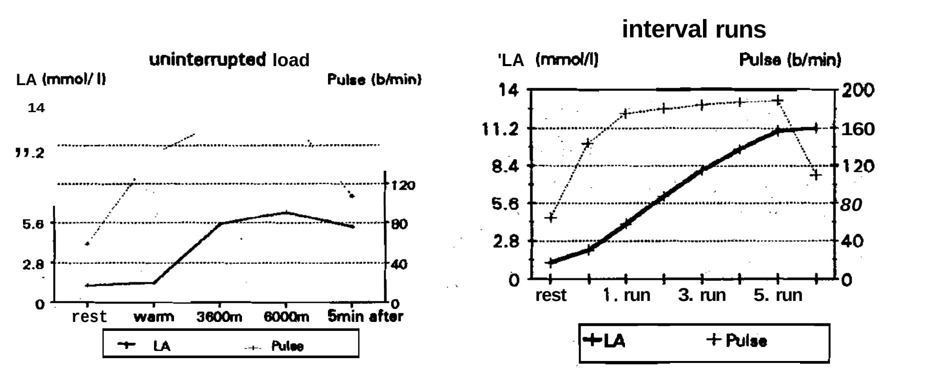

Figure 2: **Lactatekinetics and** the dynamics of the **heartbeat** frequency **before,** during and after the uninterrupted and interval loads.

The influence of a cyclic **monostructural** load on the endurance ability of muscular contractile system

The contractile force at the end of the uninterrupted load **amounts** to **13.7±** 12% at the end of the 25-second long voluntary isometric contraction **F_{M3},** which is lower than the force before the exertion (the difference is statistically significant), whereas the interval load causes only a **7.6±** 21.4% decrease in isometric force. (Figure 3)

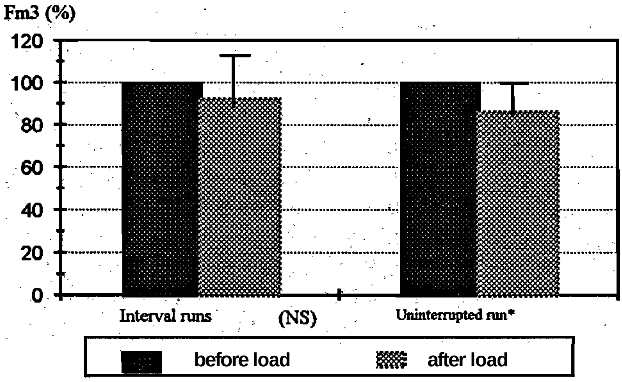

Figure 3: The **influence** of loads of various types on muscular force F_{M3}

The influence of a cyclic monostructural load on the mechanisms of central fatigue

The decrease in voluntary muscular force amounts to **2.7± 5.9%** at the end of the interval load, and to **4.6± 5.6%** after the uninterrupted load. (Table **1**)

Table **1**:
The index of the decrease in voluntary and electrically induced muscular force Fv and **Fs (AS+ SD)** and the index of difference between' the state before and after loads of different types **(AS+ SD)**

Type of load/Param.	Before the load	After the load	Difference in %	P
Fv (%) Interval runs	**2.2± 9.8**	**-2.7± 5.9**	**4.9± 13.9**	*
Fs (%)	**-3.7± 4.3**	**-6.5± 4.9**	**2.7± 5.9**	**NS**
Fv (%) Uninterrupted run	**-4.1± 6.3**	**-4.6± 5.6**	**0.5± 5.5**	**NS**
Fs (%)	**-7.7± 4**	**-5.9± 2.5**	**1.92 3.8**	**NS**

Even after the completed running load the index of the decrease in stimulation force is higher than the index of the decrease in isometric muscular force, which proves that the fundamental reasons for the decrease in the contractile muscular ability lie **predominatly** in peripheral mechanisms. The results in Table **1**, however, show that **the** difference between the indices Fv and Fs decreases after the running load. Before the load this difference is **5.9** or **3.6%**, and after the load **3.8** (after the interval runs) **and 1.2%** after the uninterrupted exertion. The decreases of the differences between the degree of fatigue of voluntary and induced muscular contraction after the load means a increase in the influence of the mechanisms of central fatigue. (Table **2**)

Table 2:
The central fatigue index I_{CF} before and after loads of different types and the **differences (AS+ SD)** between the state before and after loads of different types

Time of measurement	Before the load	After the load	Difference in %	P
Interval runs	**5.9± 6.4**	**3.8± 6.2**	**2.2± 11.8**	NS
Uninterrupted run	**3.6± 4.3**	**1.224.8**	**1.4± 5**	NS
Difference	**1.4± 6.1**	**2.7± 8.4**		

DISCUSSION

The activity of various muscle structures (motor units with different muscle fibres) differs for running loads of different intensities. That is why the extent of biochemical and biophysical changes - disorders in the individual muscular system - differs, too. The research results show that the decrease in endurance ability of the muscular contractile system is greater after an uninterrupted long-lasting aerobic load. than after the more intensive anaerobic-lactate exertion. On the basis of the results of this study and of the data of other research (Bigland-Ritchie, 1983; Jones, 1979; Binder 1992) it seems that an uninterrupted 6- kilometre run and the maintenance of a maximal isometric contraction through a longer period (when F_{M3} has been measured) cause the fatigue of motor units with the similar frequency of firing, one that is lower than the frequency of firing of motor units in the faster interval runs.

The consequences of intensive or long-lasting running exertion are seen in the supersaturation of the central nervous system, when the flow of signals from proprioceptors and chemoreceptors from the active parts of organism is very intensive. The psychological barriers most certainly have an important influence on the extent of central fatigue, as well.

The share of central fatigue in the gradient of the decrease in muscular effectiveness is greater after the completed long-lasting load in comparasion to the values after the interval runs. (Tables 1 and 2). Although the acidity of organism is considerably lower after a 20-minute run at the speed of 5 m/s, when if compared with five 45-second runs at the speed of 6.8 m/s and with a one-minute break, a lengthy exertion and its regularity (monotony) can cause a particular level of saturation ("torpidity" of motor centres of the nervous system), drop in the motivation of a runner and thereby a decrease in muscular contractile ability.

An additional important finding of this study is that after the running load, the influence of the central mechanisms on the level of muscle fatigue is increased, but it does not surpass the influence of the peripheral (local) mechanisms in the sample of the chosen runners.

CONCLUSIONS

The most important conclusions of this study are:

1. The drop in the endurance capability of the neuro-muscular system, after a continuous aerobic activity, is greater than after the more intensive anaerobic-lactic interval work-load.

2. The influence of the central mehanisms on the state of muscular fatigue increases after a cyclic monostructural activity, however, with well-trained subjects the influence of central fatigue in no case dominates.

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