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POSTURAL SWAY AFTER EXERCISE BOUTS ELICITING THE SAME HEART RATE WITH DIFFERENT ENERGY YIELD FROM ANAEROBIC GLYCOLYSIS

Erika Zemková, Dušan Hamar

Department of Sports Medicine, Institute of Sports Sciences, Faculty of Physical Education and Sports, Comenius University, Bratislava, Slovakia

ABSTRACT

The aim of the study was to compare the parameters of balance after exercise bouts eliciting the same heart rate, however with different energy yield from anaerobic glycolysis. The group of 18 physical education students underwent in different days two exercise bouts on the cycle ergometer. In the first, initial intensity of 100 W was increased by 20 W per minute. In the second, constant intensity of previously established maximal aerobic power was applied. Both tests were finished as soon as heart rate reached the level of 160 bpm. Two minutes prior to and two minutes after exercise mean velocity of the center of gravity was registered by means of force platform based on stabilographic system FiTRO Sway check. Results showed that in initial 5-seconds phase of recovery the velocity of the center of gravity was significantly ($p<0.05$) higher after short term maximal exercise (25.4 mm/s) than after continuously increasing one (14.7 mm/s). On the other hand, in the final 5-seconds period of second minute there were no significant differences in velocity of the center of gravity after both exercises (9.2 and 8.7 mm/s, respectively). However, in both cases values did not return to pre-exercise level (6.8 and 6.4 mm/s, respectively). Differences in the postural stability immediately after exercise were very probably due to higher blood lactate after short term more intensive exercise as compared to exercise with incremental protocol (8.8 and 4.9 mmol/l, respectively). Its higher concentration stimulated more profoundly the respiratory center, what resulted in higher ventilation as compared to incremental exercise (83,4 and 52,0 l/min, respectively). In addition, higher oxygen deficit had to be paid off during recovery because of previous abruptly instituted maximal exercise. Thus pronounced post-exercise breathing rate may be responsible for more impaired postural stability. It may be concluded that despite of the same heart rate response, abrupt more intensive and shorter exercise impairs the parameters of balance in early phase of recovery more profoundly than longer stepwise exercise with lower contribution of anaerobic glycolysis.

Keywords: anaerobic glycolysis, intensity of exercise, postural balance, stabilographic platform

Introduction

It has been documented (2, 3, 5, 8, 11, 13) that exercise load has destabilizing effect on postural stability. In sport such as biathlon, where impaired postural stability resulting from prolonged cross-country skiing adversely affects the standing shooting performance (12), reestablishment of such an impaired balance to a pre-exercise level is considered as an important ability.

However, in current practice heart rate is usually the only parameter used to specify the intensity of exercise without paying any attention to the type of exercise. In fact, the same heart rate may be elicited by exercise with different intensity, duration, and contribution of anaerobic energy. It may be assumed that such differences may affect some motor function, in this case the postural stability.

Therefore, the aim of the study was to compare the parameters of balance after exercise bouts leading to the same heart rate, however with different energy yield from anaerobic glycolysis.

Material and methods

A group of 18 physical education students (mean age 20.6 ± 2.0 years, height 182.0 ± 6.2 cm and weight 75.8 ± 7.8 kg) underwent in different days two exercise bouts on the cycle ergometer. In the first, initial intensity of 100 W was increased by 20 W per minute. In the second, constant intensity of previously established maximal aerobic power was applied. Both tests were finished as soon as heart rate reached the level of 160 bpm. Average duration of both exercises on the cycle ergometer was 8 and 1.5 min, respectively.

Two minutes prior to and two minutes after exercise stabilographic parameter (mean velocity of the center of gravity) was registered by means of force platform based on stabilographic system FiTRO Sway check (4). Subjects were instructed to minimize postural sway by standing as still as possible.

During exercise on the cycle ergometer as well as during standing on the stabilographic platform the parameters of ventilation and heart rate were continuously monitored using the equipment AeroSport VO 2000.

Blood samples from the fingertip were taken in the 6th minute of recovery for the estimation of lactate concentration. Enzymatic method (Boehringer sets) was used for the analysis.

Results and discussion

Results showed (Fig. 1) significantly ($p<0.05$) higher increase in velocity of the center of gravity immediately after shorter maximal exercise from 6.8 to 25.4 mm/s than after continuously increasing one from 6.4 to 14.7 mm/s. On the other hand, in the final 5-seconds period of second minute of recovery there were no significant differences in velocity of the center of gravity after both exercises (9.2 and 8.7 mm/s, respectively).

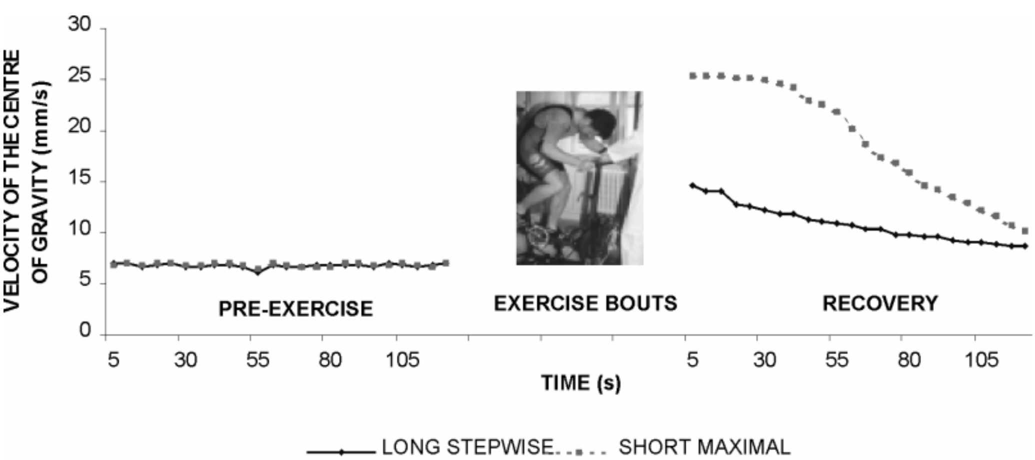

Figure 1. *Velocity of the center of gravity prior to and after short term maximal exercise and continuously increasing load, respectively*

Differences in the postural stability immediately after exercise are very probably due to higher blood lactate after short term more intensive exercise as compared to exercise with incremental protocol (8.8 and 4.9 mmol/l, respectively). Despite the fact that increased concentration of hydrogen ions is partly compensated by the buffer systems, it also stimulates the respiratory center and increases ventilation.

This can be documented by its higher peak as well as mean values (2 initial minutes of recovery) after short term more intensive exercise (108,0 and 87,9 l/min, respectively) than after longer stepwise exercise (83,4 and 52,0 l/min, respectively). In addition, ventilation remained temporarily elevated and only after about 45 seconds started to decrease gradually back to the resting level (Fig. 2). Similar trend was evident for heart rate (Fig. 3).

Besides higher blood lactate, short-term abruptly instituted maximal exercise is associated also with higher oxygen deficit.

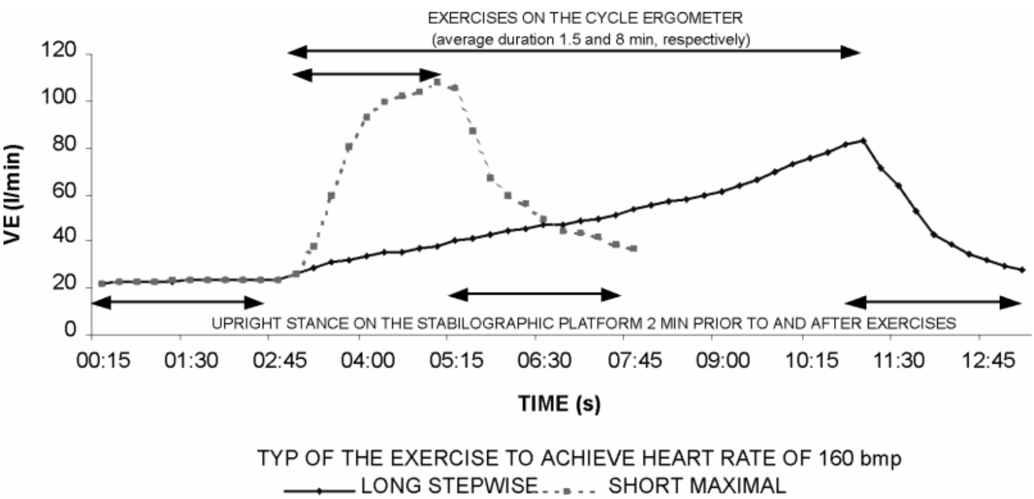

Figure 2. *Ventilation after short term more intensive exercise and exercise with incremental protocol, respectively*

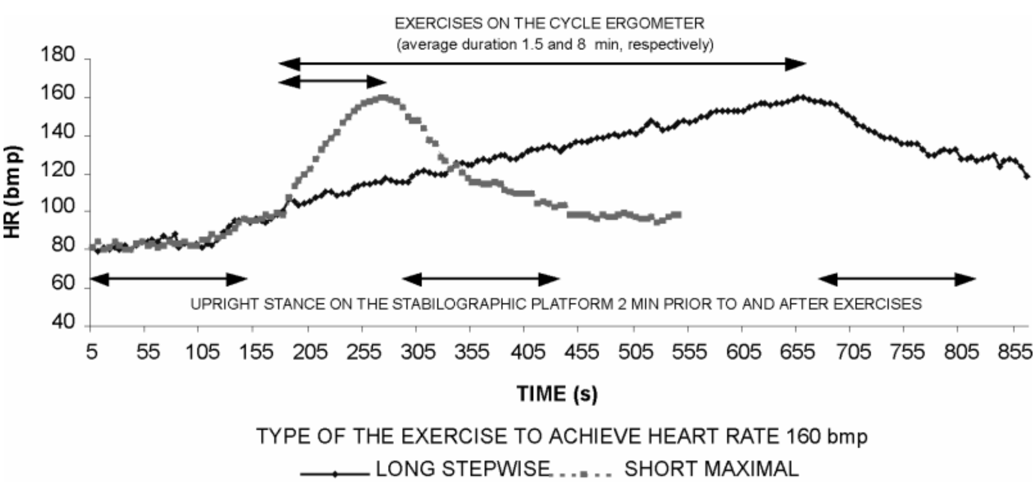

Figure 3. *Heart rate during more and less intensive exercise, respectively*

This means that more oxygen deficit had to be paid off during recovery, what also contributed to more pronounced elevation of ventilation and heart rate.

Hence, more marked ventilation as a means of respiratory compensation of lactate induced metabolic acidosis caused by short, highly intensive exercise may contribute to more profound impairment of postural stability. This finding is in agreement with the reports of several authors (1, 6, 7, 10) who found that higher breathing rate significantly affect postural stability.

Hyperventilation may affect several links of the postural control chain. This dynamic process involves a complex interaction between sensory organs, central processing and motor elements.

Sakelleri et al. (10) suggest that hyperventilation disrupts mechanisms mediating vestibular compensation. Since vestibular apparatus informs the brain about head and body movement relative to gravity, its role in maintenance of balance is essential.

In addition, an increase in sway during hyperventilation may be partly mediated by deranged peripheral and central somatosensory inputs from the lower limbs (10). The proprioceptive afferent inflow from the ankle region and impulses from pressure receptors located in the sole of the foot are of special importance. On basis of this information the motor plan in central nervous system is formatted and adequate movements for maintenance of balance are produced.

Besides higher respiration, also central (11) and local fatigue in muscles of lower extremities (9) might partly impair postural stability. However, such an effect is usually a consequence of prolonged exercise, as shown by Derave et al. (3) after 30 min of treadmill walking and running, respectively or Lepers et al. (8) after 25 km running and 1 h 44 min cycling, respectively.

Therefore it may be assumed that impairment of postural stability after short-term maximal exercise was mediated mainly by hyperventilation. This assumption may be corroborated by close correlation between the movement center of gravity and level of ventilation in recovery phase after such an exercise.

It may be concluded that abrupt maximal and shorter exercise represents intensive stimulus for respiratory system and it is one of the main reason why this type of exercise had more detrimental effect on parameters of balance than longer stepwise exercise with lower activation of anaerobic glycolysis.

Conclusion

The present study showed that despite of the same heart rate response, abrupt more intensive and shorter exercise has in early phase of recovery more detrimental effect on parameters of balance than longer stepwise exercise with lower contribution of anaerobic glycolysis. It appears that metabolic response to exercise plays important role in maintenance of balance. Therefore, this fact has to be taken in account in sport dependent on post-exercise postural stability, such as biathlon, basketball, gymnastics, rockenroll, figure skating and so forth.

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Address for correspondence:
Erika Zemková, Ph. D.
Department of Sports Medicine
Institute of Sports Sciences
Faculty of Physical Education and Sports
Comenius University
Bratislava
Slovakia