The Effects of the Different Frequencies of Whole-Body Vibration after a Strenuous Activity on Blood Lactic Acid

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ABSTRACT

Background. Fatigue has an undesirable effect on the continued exercise performance and decreases athlete's activity. Fast lactic acid disposed is high of importance for athletes.

Objectives. Therefore, the present article determines the effects of the different frequencies of whole-body vibration after a strenuous activity on blood lactic acid.

Methods. 60 athletes were chosen from selected athletes of provincial championship through bruce test. The athletes randomly were divided into four groups of 15 participating in the initial recovery scheme after strenuous exercise (Cunningham test). The first group did initial passive/inactive recovery that the subjects sat on a chair after exercise and the second to fourth did initial 15 minutes active retrieval on the vibration platform at different rate/with different speed. Their blood lactic acid was checked in three phases by manual lactometer (before activity, immediately after the activity, 15 minutes recovery period the initial situation).

Results. The result of this research indicated that the average level of lactic acid immediately after activity to before activity among 4 groups was significantly different (P=0.006). decrease in lactic acid 15 minutes after the initial state recovery to immediately after that, was significant in all groups (p<0.001). In initial recovery with 20 HZ WBV at amplitude of 5mm lactic acid repelling excretion was the most.

Conclusion. In general, it is showed that to excrete the lactic acid after exhausting and intense activity active initial state recovery scheme with whole-body vibration (WBV) at 20 HZ and on amplitude of 5mm had much more useful effects on reducing lactic acid after exhausting and intense activities than other schemes. Hence, active initial recovery with whole – body vibration at mentioned rate is recommended to remove immediately the lactic acid from the body after intense anaerobic exercise.

KEY WORDS: Blood Lactate, Fatigue, Recovery, Whole-Body Vibration, Exhaustive Exercise.

INTRODUCTION

Intense exercise leads to production of lactic acid and hydrogen ions in muscles which reduce the intracellular PH (1, 2). This acidosis harms muscle contraction and glycolytic enzyme activities, thus reducing the athletic performance (2). It is vital for athlete to rapidly remove lactic acid from the body, especially when the repetition is considered (3, 4). Generally, the blood lactic acid removal is accelerated by active recovery (4-18).

Whole-body vibration (WBV), as a physical activity helps in muscle strengthening, cardiovascular fitness, increased oxygen consumption and neuromuscular factors.
affecting fatigue mechanism (19-22). In a study, it was concluded that vibration before and after exercise helps reduce fatigue and accelerates recovery (23). A study was conducted to evaluate the effects of WBV during the recovery after intense exhausting activities. The results revealed that both low and high repetition in vibration exercise during the recovery period after exhausting activities cannot cause improvement. However, high reps in vibration may further facilitate the process of oxygen consumption to return to the initial levels in the primary recovery (24).

Another study concluded that oxygen consumption is significantly increased in young and older adults by vibration; nevertheless, such an increase in oxygen consumption by WBV may act as incentives to improve cardiovascular fitness (25).

Another study showed that WBV exercise improves cardiovascular endurance and plays an important role in neuromuscular mechanism (26). The other study considered dynamic stretching as the best way to remove lactic acid from the body after intense exhausting activity (27). Other studies argued that severe vibration is not useful in the recovery phase (28), WBV is not efficient enough compared to natural recovery (29), passive vibration is effective to reduce heart rate (30), high-speed WBV with higher amplitude is more useful (31), and low-speed vibration cannot be effective for lactic acid excretion (32).

Results of studies conducted in this area are contradictory in some cases and there are few studies on the effects of WBV on the amount of lactic acid removed from the body. Therefore, this study aimed to investigate the effect of WBV with various speeds on the amount of lactic acid removal.

MATERIALS AND METHODS

Participants. 60 male athlete students selected based on the 7-step Bruce protocol and divided into four 15-member groups by simple random sampling. This number of samples was chosen from selected athletes of provincial championship through bruce test. The athletes randomly were divided into four groups of 15 participating in the initial recovery scheme after strenuous exercise (Cunningham test). The first group did initial passive/ inactive recovery that the subjects sat on a chair after exercise and the second to fourth did initial 15 minutes active retrieval on the vibration platform at different rate /with different speed. Their blood lactic acid was checked in three phases by manual lactometer (before activity, immediately after the activity, 15 minutes recovery period the initial situation).

Training Protocol. The intense exhausting exercise considered in this study was the Cunningham test in. After the Cunningham test, all groups had a 15-minute recovery and lactic acid was measured in three phases (before the test, immediately after the test, 15 minutes after the recovery). The recovery period for groups was as:

Group A: inactive recovery (seated);
Group B: active recovery with WBV at 10 Hz an amplitude of 5 mm;
Group C: active recovery with WBV at 20 Hz an amplitude of 5 mm;
Group D: active recovery with WBV at 30 Hz an amplitude of 5 mm.

Statistical Analysis. To analyze the obtained data, some tests were conducted including Shapiro-Wilk, ANOVA (or Kruskal-Wallis), and Tukey post hoc. Statistical analysis was performed by SPSS18 software at significant level $p<0.05$.

RESULTS

Some demographic characteristic is shown in table 1. Table 2 shows resting heart rate and immediately after exercise as well as exercise time in studied groups. There was a significant difference between the lactic acid level at rest ($p=0.026$), immediately after the exercise ($p<0.001$) and 15 minutes after recovery ($p<0.001$) (Table 3). Lactic acid increased immediately after the exercise compared to before the exercise. There was a significant different in lactic acid level immediately after the exercise and before the exercise in the four groups ($p=0.006$) (Table 4). The increase in lactic acid immediately after the exercise compared to before the exercise was higher for group B than group A ($p = 0.007$). No significant difference was observed in other groups.
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Table 1. Demographic characteristic (Mean ± SD).

| Group | Age (year) | BMI (kg/m²) |
|-------|------------|-------------|
| A     | 23.7 ± 1.5 | 23.7 ± 3.4  |
| B     | 23.6 ± 1.8 | 23.5 ± 2.1  |
| C     | 23.1 ± 1.6 | 22.9 ± 1.4  |
| D     | 22.9 ± 1.4 | 23.5 ± 2.3  |

A: inactive recovery (seated); B: active recovery with WBV at 10 Hz an amplitude of 5 mm; C: active recovery with WBV at 20 Hz an amplitude of 5 mm; D: active recovery with WBV at 30 Hz an amplitude of 5 mm.

Table 2: Resting and exercise heart rate and exercise time in studies groups (Mean ± SD).

| Group | Resting heart rate | Exercise Heart rate | Exercise time (S) |
|-------|--------------------|---------------------|-------------------|
| A     | 70 ± 5             | 172 ± 6             | 400 ± 40.8        |
| B     | 68 ± 3             | 174 ± 5             | 410 ± 42.6        |
| C     | 69 ± 4             | 172 ± 5             | 419 ± 45.7        |
| D     | 70 ± 4             | 173 ± 13            | 412 ± 55          |

A: inactive recovery (seated); B: active recovery with WBV at 10 Hz an amplitude of 5 mm; C: active recovery with WBV at 20 Hz an amplitude of 5 mm; D: active recovery with WBV at 30 Hz an amplitude of 5 mm.

Table 3. Lactic acid (mmol/L) (Mean ± SD).

| Group | Resting | Exercise | 15 min Recovery |
|-------|---------|----------|-----------------|
| A     | 3.75 ± 0.58 | 11.81 ± 1.52 | 10.02 ± 1.38    |
| B     | 4.11 ± 0.77 | 13.33 ± 0.88 | 9.53 ± 0.92     |
| C     | 4.05 ± 0.25 | 12.99 ± 0.50 | 6.07 ± 0.53     |
| D     | 4.37 ± 0.40 | 12.78 ± 0.51 | 9.08 ± 0.91     |

A: inactive recovery (seated); B: active recovery with WBV at 10 Hz an amplitude of 5 mm; C: active recovery with WBV at 20 Hz an amplitude of 5 mm; D: active recovery with WBV at 30 Hz an amplitude of 5 mm.

Table 4. Acute and recovery response of lactic acid to exercise test (Mean ± SD).

| Group | Acute response to exercise respect to pretest | 15 min recovery respect to pretest | Delta acute to 15 min response to exercise test |
|-------|---------------------------------------------|-----------------------------------|-----------------------------------------------|
| A     | 8.05 ± 1.35                                 | 6.27 ± 1.32                       | 1.79 ± 0.65                                    |
| B     | 9.22 ± 1.07                                 | 5.41 ± 1.07                       | 3.81 ± 0.80                                    |
| C     | 8.93 ± 0.41                                 | 2.02 ± 0.53                       | 6.91 ± 0.60                                    |
| D     | 8.41 ± 0.65                                 | 4.71 ± 0.95                       | 3.7 ± 1.22                                     |
| P     | 0.006                                       | P < 0.001                         | P < 0.001                                      |

A: inactive recovery (seated); B: active recovery with WBV at 10 Hz an amplitude of 5 mm; C: active recovery with WBV at 20 Hz an amplitude of 5 mm; D: active recovery with WBV at 30 Hz an amplitude of 5 mm.

DISCUSSION

As measured, the mean lactic acid concentration for the inactive group was 3.75 mmol/lit at rest. After the Cunningham test (the maximum intense exercise) which is a short-term anaerobic test, the concentration of lactic acid in the blood was increased to 11.81 mmol/lit. Then, this group experienced an inactive recovery (seated) and after a 15-minute recovery, the lactic acid concentration was again measured showing a mean of 10.02 mmol/lit.

In the active group, the average concentration of lactic acid at rest was 4.37, 4.05, and 4.11 mmol per liter at WBV with 10, 20, and 30 Hz speed, respectively. After the Cunningham test, the average values increased to 12.78, 12.99, and 13.33 mmol per liter, respectively. Then the three groups passed the recovery program using WBV and 15 minutes after the recovery, the
average concentrations of lactic acid in the blood were measured as 9.08, 6.07, and 9.53 mmol per liter. As a result, there was a significant difference between the lactic acid level at rest (p = 0.026), immediately after the exercise (p < 0.001) and 15 minutes after recovery (p < 0.001).

In addition, there was a significant difference in lactic acid level in 15 minutes after recovery for all groups while this value was highest for A and lowest for C.

According to findings in this study, active recovery is much more useful than inactive one and this is consistent with findings of other researches (4-18).

Results obtained by this study are consistent with the findings of some other studies examining the effects of vibration study (19-22) and not consistent with other studies (24, 27-29). This may be due to small sample size or different approaches. So a study with a larger sample size is recommended. The results showed that low- or very high speed vibrations do not result in faster disposal of lactic acid in the body which are consistent with some studies (31, 32). The reason for this may be the fact that very high speed vibration is an intense activity that not only does not reduce the lactic acid levels, but also results in higher accumulation of lactic acid.

The mean reduction in the level of lactic acid immediately after exercise compared to 15 minutes after recovery in inactive and active groups at 10, 20, and 30 Hz speed with amplitude of 5 mm was 3.70, 6.91, 3.81, and 1.79 mmol per liter, indicating a significant difference (P < 0.001). As obvious, the average reduction in C was significantly higher (P < 0.001) than other groups suggesting that active recovery with WBV at 20 Hz and amplitude of 5 Mm desirable Terry in the amount of lactic acid after a grueling and intense activity will be.

CONCLUSION

Generally, based on the findings, we can conclude that an active recovery with WBV at a speed of 20 Hz and amplitude of 5 mm may have more favorable effects on lactic acid removal after an intense exhausting exercise. Therefore, to faster remove the lactic acid from the body after an intense anaerobic activity, an active recovery with whole-body vibration at the specified speed is recommended.

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