[Sports Physical Therapy]

Effect of Active Versus Passive Recovery on Performance During Intrameet Swimming Competition

Jaime Hinzpeter, MD,*† Álvaro Zamorano, MD,† Diego Cuzmar, MD,† Miguel Lopez, MD,† and Jair Burboa†

Background: During competition, high-performance swimmers are subject to repeated physical demands that affect their final performance. Measurement of lactate concentration in blood seeks to indirectly gauge physiologic responses to the increase in physical exercise. Swimmers face multiple maximal-exertion events during competition. Strenuous physical exercise leads to fatigue and, thus, a decrease in sports performance.

Hypothesis: Regeneration exercises in swimming increase the clearance of blood lactate and therefore improve athletic performance within a single day of competition.

Study Design: Crossover study.

Level of Evidence: Level 1.

Methods: Of 25 swimmers, 21 were included, with a mean age of 17 years. They performed exercises that increased blood lactate on 2 days. The protocol was a warm-up, followed by a 100-m freestyle workout at full speed. Swimming exercises followed that were increasingly demanding, during which serial lactatemia measurements were taken. On the first day, regeneration exercises were performed; on the second day, the swimmers rested. Next, lactatemia was measured, and a timed 100-m freestyle workout was performed at maximum speed.

Results: The stress exercises increased the mean lactate concentration by 4.6 mmol/L, which corresponds to 78% of the initial basal level. The postregeneration lactatemia level was lower than that after resting (mean, 2.76 vs 6.51 mmol/L). The time to swim 100 m after regeneration was 68.11 seconds, while that after rest was 69.31 seconds.

Conclusion: Blood lactate levels rose by up to 78% after the intensity of the training sessions was progressively increased. Regeneration exercises increased the rate in which blood lactate dissipated, in comparison with passive recuperation. The rate of lactate dissipation for regeneration exercises was 68%. This factor may have improved the physical performance of swimmers.

Clinical Relevance: Regeneration exercises improved the performance of swimmers in maximal-exertion competition in a single day. The blood lactate level correlated with physical exercise load.

Keywords: lactate; exercise; regeneration; swimming

Historically, lactatemia measurements have been used in swimming to help measure progress and the effectiveness of training programs.[10] The relationship between the accumulation of lactate and a decrease in performance is documented.[13]

In the 1980s, methods were sought to increase clearance of blood lactate to decrease its deleterious effects on muscle metabolism.[9] Regeneration exercises (light training exercises) both in and out of the pool, massages, immersion in cold water, and other techniques were studied. Many of these methods decreased lactate, preventing its accumulation between competitions.[9,10,14]

In a swimming competition, athletes often exert maximum performance with little time to rest between competitions, increasing the possibility of lactate accumulation. Lactatemia has been used to generate training programs, with few studies that link blood lactate during a competition to performance.

From the †University of Chile Clinical Hospital, Santiago, Chile

*Address correspondence to Jaime Hinzpeter, MD, Clinical Hospital, University of Chile, Santos Dumont 999, Santiago, Chile (e-mail: jhchinzpeter@yahoo.com).

The authors reported no potential conflicts of interest in the development and publication of this manuscript.

DOI: 10.1177/1941738113500769

© 2013 The Author(s)

Downloaded from sph.sagepub.com at UNIVERSIDAD DE CHILE on December 16, 2014

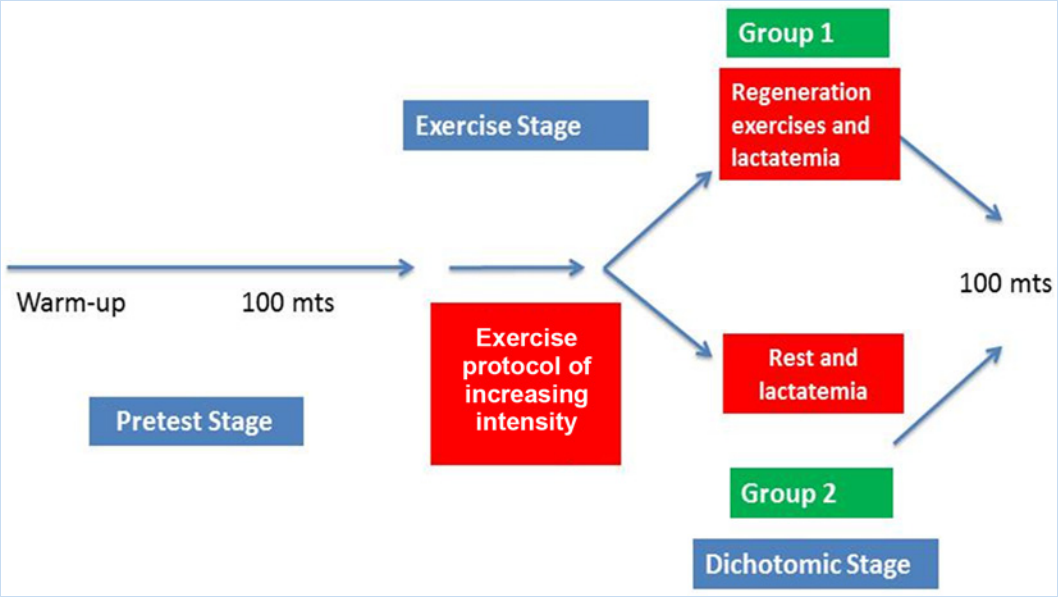

Figure 1. Protocol of evaluation. Pretest stage: warm-up, followed by the overload stage (exercise stage), where lactate levels of swimmers were measured as their physical intensity increased. In the dichotomous stage, one group performed regeneration exercises while the other rested. After this stage, each participant swam 100 m of freestyle to compare the performance.

METHODS

The ethics committee of the University of Chile Clinical Hospital approved this project. This prospective study followed 25 young swimmers; 4 were excluded because they did not complete the cycle of measurements required for the study. The mean age was 17 years (range, 15-19 years), and participants had a mean body mass index of 22.22 and mean fat percentage of 11.35%. The protocol consisted of 3 stages. The pretest stage consisted of a 20-minute warm-up of stretching exercises both in and out of water and a timed 100-m freestyle swim at peak performance, followed by a 5-minute rest. In the second stage, an exercise protocol of increasing intensity was performed, with serial lactatemia measurements based on an existing training program.[3,6] This protocol consisted of 3 sets of freestyle sprints (4 × 200 m) with increasing intensity. The first set was performed at 65% to 70% intensity, the second at 80%, and the final set at 100%. Exercise intensity was adjusted to each participant's heart rate through a Polar RS400SD running computer with heart rate monitor (Polar Electro, Lake Success, New York) (intensity: 70% = 150*x*′, 80% = 160*x*′, 100% = 180*x*′-190*x*′). Between each set, lactatemia was registered using an Accutrend lactate analyzer (Roche, Indianapolis, Indiana) 3 to 5 minutes after the end of the series.

The final stage was dichotomous, and the 2 groups of swimmers were randomly selected. The first group performed active recuperation exercises (regeneration) with 20 minutes of low-intensity swimming (50%-60%); the second group rested (passive recuperation). After the recuperation period, the performance evaluation stage consisted of a 100-m freestyle swim at maximum speed. Lactatemia levels were measured after the regeneration exercises and after the rest period (Figure 1). The Shapiro-Wilk test was initially used to evaluate the distribution of data. Data were not normally distributed; therefore, nonparametric tests were used to evaluate the results (Wilcoxon Mann-Whitney test).

RESULTS

A progressive increase in lactatemia was evident with the increase in intensity exercise. Both groups saw an increase of 4.6 mmol/L, which corresponds to an increase of 78% for lactate with exercise. In the recovery phase, the active-exercise recovery group saw a mean decrease of 5.93 mmol/L, which corresponds with 68% of the initial lactate total, while the group that rested saw a decrease of 1.63 mmol/L, which corresponds with 20% of the initial total. This difference was significant ($P = 0.03$) (Figure 2).

The time to swim 100 m after regeneration was 68.11 seconds, while after rest it was 69.31 seconds. Again, this difference was significant ($P = 0.04$) (Figure 3).

DISCUSSION

For swimmers, the goal of training is to improve physical performance. Training programs must balance intensity and rest periods between competitions. Unbalanced programs produce fatigue and poor sports performance. Physiologic adaptation to fatigue can be measured through different methods, including questionnaires and blood lactate sampling.[6,8]

Downloaded from sph.sagepub.com at UNIVERSIDAD DE CHILE on December 16, 2014

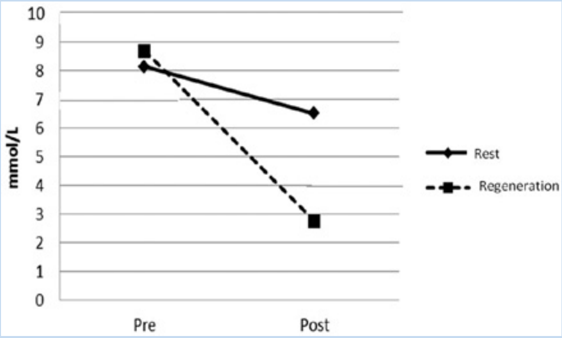

Figure 2. Mean lactatemia measured before and after the dichotomous stage.

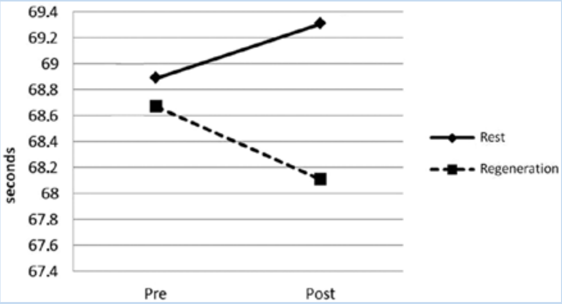

Figure 3. Mean performance comparing the rest group to the regeneration group.

Active recuperation maintains an elevated metabolic range that does not significantly activate the anaerobic glycolytic pathways. This increase in metabolic range boosts the clearance of lactate through accelerated oxidation.[3,4,9]

Lactate is not part of the creatine phosphate system, either as a substrate or as a product, but its blood level is helpful to monitor. When exercising, the body (once exhausted) uses other power sources, such as glycolysis, which facilitates the production of lactate to reduce pyruvic acid. The lower the plasma lactate levels after a speed workout, the better the functioning of creatine phosphate, resulting in a lower need to pursue other forms of energy.[4] Lactate levels indirectly reflect muscle metabolism.

The production of lactate generates hydrogen ions.[5,9] The accumulation of these ions produces intramuscular acidity that interferes with muscle contraction, resulting in a deficit of the force generation, which is muscle fatigue.[9] Lactate is related to fatigue, and it is an indicator of it but does not produce fatigue.[5]

Oh et al[11] studied exercise capacity using lactate values. In this study, the incremental stage of training demonstrates the progressive increase of lactate as the exercise load is increased. The clearance of blood lactate has been the subject of numerous studies.[1,2,7,9] Recuperation exercises based on an athlete's rhythm have been more effective at purification than passive recuperation.[2]

The dichotomy of active versus passive recuperation is worthy of debate. Ohya et al[12] demonstrated that active recuperation can result in a poorer performance and low muscle reoxygenation. Our data differ, which could be due to the low number of participants in both studies or the different types of exercises used. Greco et al[7] studied types of active and passive recuperation in prolonged, intermittent exercises, observing no differences between them.

Ali Rasooli et al[1] studied different types of active and passive recuperation in swimmers and found that active recuperation increases the clearance of lactate on a greater scale than do massages and rest. These data are analogous to our study, which was performed in a similar group of participants (professional swimmers).

There are limitations to our study, including that it may not be generalizable to swimmers with different experience levels or training regimens.

CONCLUSION

Swimmers subjected to active recuperation exercises may have better athletic performance and lower blood lactate values than those subjected to passive recuperation.

REFERENCES

1. Ali Rasooli S, Koushkie Jahromi M, Asadmanesh A, Salesi M. Influence of massage, active and passive recovery on swimming performance and blood lactate. *J Sports Med Phys Fitness*. 2012;52:122-127.
2. Belcastro AN, Bonen A. Lactic acid removal rates during controlled and uncontrolled recovery exercise. *J Appl Physiol*. 1975;39:932-936.
3. Brooks GA. Anaerobic threshold: review of the concept and directions for future research. *Med Sci Sports Exerc*. 1985;17:22-34.
4. Brooks GA. Current concepts in lactate exchange. *Med Sci Sports Exerc*. 1991;23:895-906.
5. Connett RJ, Gayeski TE, Honig CR. Energy sources in fully aerobic rest-work transitions: a new role for glycolysis. *Am J Physiol*. 1985;248:H922-H929.
6. Elloumi M, Makni E, Moalla W, et al. Monitoring training load and fatigue in rugby sevens players. *Asian J Sports Med*. 2012;3:175-184.
7. Greco CC, Barbosa LF, Caritá RA, Denadai BS. Is maximal lactate steady state during intermittent cycling different for active compared with passive recovery? *Appl Physiol Nutr Metab*. 2012;37:1147-1152.
8. Kellman M. Preventing overtraining in athletes in high intensity sports and stress/recovery monitoring. *Scand J Med Sci Sports*. 2010;20(suppl):95-102.
9. Martin NA, Zoeller RF, Robertson RJ, et al. The comparative effects of sports massage, active recovery, and rest in promoting blood lactate clearance after supramaximal leg exercise. *J Athl Train*. 1998;33:30-35.
10. McMaster WC, Stoddard T, Duncan W. Enhancement of blood lactate clearance following maximal swimming: effect of velocity of recovery swimming. *Am J Sports Med*. 1989;17:472-477.
11. Oh SL, Chang H, Kim HJ, et al. Effect of HX108-CS supplementation on exercise capacity and lactate accumulation after high-intensity exercise. *J Int Soc Sports Nutr*. 2013;10:21.
12. Ohya T, Aramaki Y, Kitagawa K. Effect of duration of active or passive recovery on performance and muscle oxygenation during intermittent sprint cycling exercise. *Int J Sports Med*. 2013;34:616-622.
13. Sesboüé B, Guincestre JY. Muscular fatigue. *Ann Readapt Med Phys*. 2006;49:257-264, 348-354.
14. Toubekis AG, Smilios I, Bogdanis GC, Mavridis G, Tokmakidis SP. Effect of different intensities of active recovery on sprint swimming performance. *Appl Physiol Nutr Metab*. 2006;31:709-716.

For reprints and permission queries, please visit SAGE's Web site at http://www.sagepub.com/journalsPermissions.nav.

Downloaded from sph.sagepub.com at UNIVERSIDAD DE CHILE on December 16, 2014