

THREE TYPES OF RECOVERY PROGRAMS ON REMOVAL OF LACTATE AFTER AN EXHAUSTIVE EXERCISE – COMPARATIVE STUDY

Iman Abd Elamier Elkhzragy , Muhammad Saad ismael

¹ Professor in faculty of physical education ,Baghdad university, Iraq

² sportive specialist in youth care office ,Mansoura university, Egypt

INTRODUCTION :

For decades, many investigations have been focused on the production and removal of lactate in relation to exercise (see for example, Van Hall et al. 2002, Draper et al. 2006). During intense exercise, lactate is produced faster than the ability of the tissues to remove it, and thus lactate concentration begins to rise. Recovery process plays an essential role in determining subsequent athletic performance

Athletes are running, swimming, and skating faster, jumping higher, throwing further, and lifting more than ever before. Records in many events continue to be broken, and in some events the pace is accelerating. For example, in just the past five years the world record in the men's 10,000 meters has been broken eight times by six different runners. Even more startling, the world record improved by nearly three percent during this period, whereas during the preceding 30 years it improved by less than two percent!

Many factors are contributing to this improvement. Coaches have increased their knowledge base because of advances in sport medicine and science. Equipment changes have led to immediate improvements, the most recent example being the clap skate in speedskating. However, it is generally accepted that the most important cause of improved performance is the training that athletes undergo, particularly for events that require endurance or superior physical conditioning.

As records have progressed, so has the level of training. Some sport scientists estimate that training loads have increased by 20% over the past decade, and far greater increases have been noted for some sports (Weltman et al .1979).

However, there is a limit to an athlete's capacity to endure and adapt to intense training. Once this threshold is crossed the athlete fails to adapt and performance declines. Ten to twenty percent of athletes who train intensively may fall prey to the overtraining syndrome, otherwise known as staleness (Kuipers, 1998; Krieder et al. 1997).

Athletes suffering from the overtraining syndrome are unable to train and perform to their capacity, and may experience a variety of other symptoms.

The term overtraining itself is fraught with controversy and confusion. Some coaches and athletes contend that there is no limit beyond which training becomes counterproductive. The term also has been used inconsistently in the scientific literature with a variety of labels attached to this condition (O'Connor, 1997). For the purposes of this paper, the following definitions will be used.

Overload--A planned, systematic and progressive increase in training with the goal of improving performance.

Overreaching - Unplanned, excessive overload with inadequate rest. Poor performance is observed in training and competition. Successful recovery should result from short-term (i.e., a few days up to one or two weeks) interventions.

Overtraining Syndrome - Untreated overreaching that results in chronic decreases in performance and impaired ability to train. Other problems may result and may require medical attention.

Lactate metabolism and its rate of elimination from blood and muscle are important components of recovery following maximal exercise.' It has been well documented that performing low-intensity aerobic exercise (active recovery) during the immediate postexercise period is more effective in accelerating lactate clearance than inactive rest (passive recovery). (Rontoyannis ,1988 : Weltman et al .1979)

Active recovery promotes lactate clearance by increasing metabolic rate and systemic blood flow, thereby accelerating lactate metabolism via oxidation and gluconeogenesis.14'8'9

Although some controversy exists regarding the optimal intensity for active exercise recovery, a metabolic rate corresponding to 40% of maximum oxygen uptake (VO₂max) has been shown to be effective for accelerating lactate clearance following maximal exercise.", (Belcastro, Bonen1975.: Gollnick, et al. 1986: Stamford et al. 1981 :Weltman et al .1979)

Sports massage is commonly used in an effort to facilitate lactate clearance despite the lack of controlled research to support its efficacy in this regard. Developed in the 1980s, sports massage incorporates classic Swedish strokes with compression, trigger-point therapy, and cross-fiber friction techniques.10 It was "designed to provide therapeutic impact to meet the unique physical and biomechanical needs of athletes" and is typically divided into pre-event/postevent and maintenance routines.(National Sports Massage Team 1987)

Specific massage techniques are thought to produce local increases in skeletal muscle blood flow via several mechanisms. Direct mechanical effects on tissue vasculature, circulatory changes secondary to the local release of vasodilators, and reflexive decreases in sympathetic tone elicited by direct tissue stimulation have all been proposed as possible explanations. (Cafarelli , Flint 1992 : Brooks 1991)

Theoretically, increases in skeletal muscle blood flow may accelerate the rate at which lactate is shuttled to various sites of elimination, thereby promoting its clearance. (Cafarelli , Flint 1992 : Callaghan 1993 : Yates 1990)

Previous studies concerning the effects of massage on skeletal muscle blood flow have been contradictory and difficult to compare due to differences in experimental designs, statistical analyses, and the massage techniques used. (Cafarelli , Flint 1992)

However, Hansen and Kristensen¹³ reported that effleurage produced a small and transient increase in blood flow. Hovind and Nielsen¹⁹⁷⁴ reported that petrissage had a variable and inconsistent effect on blood flow, while tapotement produced significant increases in blood flow comparable with exercise hyperemia. The compression stroke, the hallmark of sports massage, is reported to produce significant increases in skeletal muscle blood flow.'

However, there have been no studies to date that have examined the effect of the compression technique on either skeletal muscle flow or the rate of postexercise lactate clearance.

Currently, there is a lack of controlled research to support the efficacy of sports massage on accelerating the rate of postexercise blood lactate clearance. Therefore, the purpose of this investigation was to compare the effects of sports massage, active recovery, and passive (complete rest, sitting on the chair) in disappearance of stored lactate in runner's blood after an exhaustive exercise.

METHOD

We selected 60 volunteered athletes' students who participated in the university athletics competition. They were divided into three groups, all subjects could finish all the period of study. Blood samples were collected from athletes during the rest, after exercise and after recovery programs . The range of lactic was measured using accusport. The activity was 800 meter running with maximum possible speed of athletes.

Table 1. Subject Characteristics*

Age	Height	Weight	V02peak
*21.5 ± 3.98 yr	*171.56 ± 6.62 cm	*69.90 ± 5.46 kg	*55.87 ± 3.82 ml - kg ⁻¹ - min ⁻¹

* Values are mean ± standard deviation

Wingate anaerobic test. We used three successive Wingate cycle tests, with 2-minute rest intervals between each, to elevate blood lactate levels. The protocol calls for the subject to perform 30 seconds of "all out" (supramaximal) cycling at a very high braking force that was indexed to body weight.¹⁸

The Wingate test has been shown to rely on anaerobic glycogenolysis as the primary energy pathway, producing blood lactate concentrations ranging from 6 to 15 times above resting levels. All Wingate tests were performed on a Monark cycle ergometer interfaced with an IBM-compatible computer.

We used a software package manufactured by Sports Medicine Industries, Inc (Version 102A, 1992, St. Cloud, MN) to determine the braking force for each subject and to generate an on-line analysis of anaerobic power.

Sports Massage :

The sports massage techniques we employed in our investigation are those typically used in a postevent routine (Table 2). We used the techniques of effleurage, petrissage, tapotement, and compression in an effort to increase blood flow through the previously active muscle beds. Effleurage is defined as any stroke that glides over the skin without attempting to move the deep muscle masses.²⁰ The technique is applied with firm, even hand pressure in the direction of venous return. Petrissage consists of kneading manipulations that compress and roll the skin and muscle under the hands/ fingers.²⁰ Tapotement is any series of brisk blows that follow

Table 2. Sports Massage Protocol

Time (min:sec) Technique

Supine position

0:00 - 1:00 Compression: lower leg/quadriceps

1:00 - 1:45 Effleurage: ankle to crease of hip

1:45 - 2:30 Thumb effleurage: anterior/lateral aspects lower leg

2:30 - 3:00 Petrissage: quadriceps

3:00 - 4:30 Tapotement: quadriceps

4:30 - 5:00 Effleurage: ankle to crease of hip

Prone position

0:00 - 2:00 Compression: calf/hamstrings
 2:00 - 2:30 Effleurage: ankle to upper thigh
 2:30 - 3:30 Petrissage: calf/hamstrings
 3:30 - 4:30 Tapotement: calf/hamstrings
 4:30 - 5:00 Effleurage: ankle to upper thigh

Testing Procedures :

After the third Wingate test, subjects remained seated for 5 minutes on the cycle ergometer without pedaling, allowing blood lactate levels to reach peak postexercise levels. At the end of this 5-minute period, a blood sample was obtained and one of the three experimental conditions was immediately initiated. The procedures for the three 20-minute treatment conditions were as follows: 1) during active recovery, the subject pedaled the cycle ergometer at 80 revolutions per minute at an intensity equal to 40% VO₂peak; 2) during the massage condition, the subject proceeded immediately to a massage table positioned next to the cycle ergometer; and 3) during the rest (control) condition, the subject proceeded immediately to a table positioned next to the cycle ergometer and remained lying in the supine position for 20 minutes.

Statistical Analysis :

Statistical analysis used:

Data were analyzed by using SPSS program

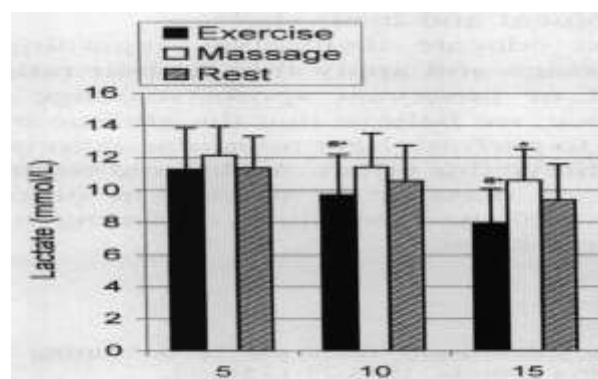
- ANOVA
- T test
- Mean

Blood sample :

The researchers used the accusport to measure the lactic acid in blood

RESULTS :

Rates of lactate in passive, active and massage recovery groups in rest were 2.17, 2.11, and 2.23, after intensive exercise were 14.97, 14.81, 14.96 in final after recovery program were 10.44, 9.12 and 10,27 respectively. The measured results for three types of recovery programs (i.e., active, passive and massage) indicated that the removal rate of the lactate in athletes' blood were not significantly different in these groups.



DISCUSSION :

It was observed that active recovery has better effectiveness on the disappearance of lactate in athletes' blood comparing to other two groups. The result also showed that massage recovery program has a better outcome than the passive recovery group. Their results provided some support for the psychological benefits of Massage comparing to passive program;

however, the efficiency of massage for blood lactate removal and speeding recovery in the repeated sports performance was questioned

Several mechanisms have been proposed to explain how metabolic acidosis predisposes an athlete to muscular fatigue.

Within the exercising skeletal muscle, acidotic shifts in Ph secondary to lactate accumulation serve to retard free fatty acid mobilization and slow glycolysis by inhibiting the activity of lactate dehydrogenase and phosphofructokinase. Both of these enzymes are important in regulating anaerobic energy production. ,3,14,26,31

In addition, high concentrations of intramuscular hydrogen ions may act to displace calcium ions from troponin, thereby inhibiting muscle contraction.",4'26 Low blood pH has also been shown to stimulate pain receptors, contributing to an increased perception of physical exertion and decreased muscular performance 1,15,22

The results of this investigation support the use of active recovery in accelerating the abatement of metabolic acidosis following high-intensity anaerobic exercise. Our findings support the work of numerous investigators who have documented the efficacy of active recovery in promoting blood lactate clearance. -26

There are several mechanisms by which active recovery serves to accelerate postexercise blood lactate clearance.

Active recovery serves to maintain an elevated metabolic rate but does not activate anaerobic glycolytic pathways to a great extent. The elevated metabolic rate during active recovery serves to promote lactate clearance via an accelerated rate of lactate oxidation.23 , 14, 6 ,13

The results of tracer studies, using isotope-labeled lactate, provide strong support for the conclusion that oxidation is by far the most significant pathway for lactate elimination, accounting for as much as 70% of lactate disposal. 1,8,9,25

Active recovery also promotes lactate clearance via an increased use of lactate as a fuel by the heart and contracting skeletal muscle.^{8,9,31} Lactate, which is produced in Type IIb fibers, is transported into Type I or IIa fibers, where it is oxidized.³³ Therefore, glycolytic fibers within an exercising muscle bed can shuttle oxidizable substrate (in the form of lactate) to neighboring cells with higher respiratory rates. The greater capillary density surrounding the slow-twitch fibers, coupled with their high lactate dehydrogenase enzyme content, suggests that the delivery, uptake, and subsequent oxidation of lactate is facilitated here.^{22,19}

The results of our investigation do not support the efficacy of sports massage in promoting blood lactate clearance after high-intensity anaerobic exercise. There are several factors that can account for our findings. The prevailing popular hypothesis is that postevent sports massage promotes lactate clearance by increasing blood flow through the skeletal muscle bed.

Although there is evidence that some massage techniques increase regional blood flow through skeletal muscle,^{13,14} the magnitude of the increase may be overestimated. Cafarelli and Flint¹ reported that when effleurage is applied to a limb, the manual pressure applied does not directly increase arterial inflow, but serves to increase arteriolar pressure and empty the veins.

Momentarily, this pressure produces a slight negative pressure in the veins that tends to draw blood in through the capillaries. The rate of blood flow is, therefore, transiently increased without an associated increase in metabolism.

Similarly, Hansen and Kristensen¹ (1973) reported that effleurage produced a small, transient increase in blood flow but concluded that even light muscular exercise would produce a greater circulatory effect. Hovind and Nielsen¹⁴ reported that petrissage did not significantly alter muscle tissue perfusion, concluding that the mechanical emptying of the vascular bed would not necessarily produce a net increase in blood flow, but may be effective for increasing lymphatic return.

When describing the effects of tapotement, Hovind and Nielsen¹⁴ noted that this technique produced immediate increases in blood flow comparable with changes associated with active muscular contractions. They reported that tapotement, specifically hacking, caused repetitive muscular contractions in the treatment area, producing increases in blood flow similar to those produced by voluntary muscular contractions. However, the report clearly stated that the technique was unpleasant to the subjects and would not usually be applied in a therapeutic setting as intensively as it was in the investigation.

Furthermore, evidence suggests that increases in blood flow alone have little or no effect on lactate clearance.

Gladden et al(1992) examined the effect of blood flow on net lactate uptake in a canine model. They reported that when metabolic rate and blood lactate concentration were held constant, a 65% increase in blood flow (above the baseline) had no effect on lactate uptake and subsequent clearance. It is our opinion that postexercise sports massage, as performed in this investigation, did not beneficially influence the pathways important to lactate metabolism and its subsequent clearance from blood and tissues.

Although the results of our investigation do not support the efficacy of sports massage in promoting postexercise blood lactate clearance, further research in this area may be justified. Examining the compression technique individually, increasing the treatment time, and determining muscle lactate concentration are possible considerations for future research.

CONCLUSIONS :

Athletic trainers are frequently asked to perform sports massage by athletes who believe that these techniques will help speed recovery and enhance performance. Such claims are reported extensively in much of the popular massage literature.

However, much of the supportive evidence for the positive effects of massage has been based on a vast body of anecdotal reports, rather than on sound scientific data obtained using modern laboratory equipment and methods.⁷ Athletic trainers must educate themselves regarding the physiologic basis of massage and apply this to their rationale for its use. If the goal of postevent sports massage is to accelerate lactate clearance, we believe that the athletic trainer should advise the athlete to perform light muscular exercise (ie, jogging or cycling) to achieve this effect. Additional controlled research on the effects of massage is needed in order for athletic trainers to make educated decisions regarding its use for sport and clinical application.

REFERENCES :

- 1- **Ahmaidi S, Granier P, Taoutaou Z, Mercier J, Dubouchaud H, Prefaut C.** Effects of active recovery on plasma lactate and anaerobic power following repeated intensive exercise. *Med Sci Sports Exerc.* 1996;28:450-456.
- 2- **Baldwin KM, Hooker AM, Herrick RE.** Lactate oxidative capacity in different types of muscle. *Biochem Biophys Res Commun.* 1978;83:151- 157.

- 3- Belcastro AN, Bonen A.** Lactic acid removal rates during controlled and uncontrolled recovery exercise. *J Appl Physiol.* 1975;39:932-936.
- 4- Brooks GA, Fahey TD.** *Exercise Physiology: Human Bioenergetics and Its Applications.* New York, NY: MacMillan Publishing Co; 1985: 203,214,707
- 5- Brooks GA, Gaesser GA.** End points of lactate and glucose metabolism after exhausting exercise. *J Appl Physiol* 1980;49:1057-1069.
- 6- Brooks GA.** Current concepts in lactate exchange. *Med Sci Sports Exerc.* 1991; 23:895-906.
- 7- Brooks GA.** The lactate shuttle during exercise and recovery. *Med Sci Sports Exerc.* 1986;18:360-368.
- 8- Cafarelli E, Flint F.** The role of massage in preparation for and recovery from exercise: an overview. *Sports Med.* 1992;14:1-9.
- 9- Callaghan MJ.** The role of massage in the management of the athlete: a review. *Br J Sports Med.* 1993;27:28-33.
- 10- Davis, J.M. & Hertler-Colbert, L.** The athlete's immune system, intense exercise, and overtraining. In: Lamb, D.R. & Murray, R. (Eds.). *Optimizing Sport Performance: Perspectives in Exercise Science and Sports Medicine.* 1997: Vol. 10, (pp.269-311).
- 11- Draper N et al.** *Journal of Sports Science and Medicine* ,2006: 5, 97 – 105.
- 12- Gisolfi C, Robinson S, Turrell ES.** Effects of aerobic work performed during recovery from exhausting work. *J Appl Physiol.* 1966;21: 1767- 1772.
- 13- Gladden LB, Crawford RE, Webster MJ.** Effect of blood flow on net lactate uptake during steady-level contractions in canine skeletal muscle. *J Appl Physiol.* 1992;72:1826-1830.
- 14- Gollnick PD, Bayly WM, Hodgson DR.** Exercise intensity, training, diet, and lactate concentration in muscle and blood. *Med Sci Sports Exerc.* 1986;18:334-340.
- 15- Hansen TI, Kristensen JH.** Effect of massage, shortwave diathermy and ultrasound upon Xenon-133 disappearance rate from muscle and subcutaneous tissue in the human calf. *Scand J Rehabil Med.* 1973;5:179-182.
- 16- Hovind H, Nielsen SL.** Effect of massage on blood flow in skeletal muscle. *Scand J Rehabil Med.* 1974;6:74-77.
- 17- Krieder, R.B., Fry, A.C. & O'Toole, M.L.** *Overtraining in Sport.* 1998:Human Kinetics: Champaign, IL.

- 18- Kuipers, H.** Training and overtraining: an introduction. *Medicine and Science in Sports and Exercise*. 1998; 30, 1137-1139.
- 19- National Sports Massage Team (Brochure)**, American Massage Therapy Association, 1987.
- 20- O'Connor, P.J.** Overtraining and staleness. In: W.P. Morgan (Ed.). *Physical Activity & Mental Health*. 1997: 145-160. Taylor & Francis, Washington, D.C.
- 21- Parkhouse WS, Mckenzie DC.** Possible contribution of skeletal muscle buffers to enhanced anaerobic performance: a brief review. *Med Sci Sports Exerc*. 1984;16:328-338.
- 22- Robertson RJ, Falkel JE, Drash AL, Swank AM, Metz KF, Spungen SA, LeBoeuf JR.** Effect of blood pH on peripheral and central signals of perceived exertion. *Med Sci Sports Exerc*. 1986;18:114-122.
- 23- Rontoyannis GP.** Lactate elimination from the blood during active recovery. *J Sports Med Phys Fitness*. 1988;28:115-123.
- 24- Stamford BA, Weltman A, Moffatt R, Sady S.** Exercise recovery above and below anaerobic threshold following maximal work. *J Appl Physiol*. 1981;51:840-844.
- 25- Van Hall G et al.** *American Journal of Physiology, Endocrinology and Metabolism*, 2002 :284, 193-205.
- 26- Weltman A, Stamford BA, Fulco C.** Recovery from maximal effort exercise: lactate disappearance and subsequent performance. *J ppl Physiol*. 1979;47:677-682.
- 27- Yates J.** *A Physician's Guide to Therapeutic Massage: Its Physiological Effects and Their Application to Treatment*. Vancouver, BC, Canada: The Massage Therapists Association of British Columbia; 1990:iii,5.