Effectiveness of Recovery Modalities on Removal rate of Blood Lactate Which is induced from Maximal All out Exercise In selected young male sports person.

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ABSTRACT

Background: *It is a common practice to apply different modalities such as massage, passive and active recovery in between and at the end of sport competition to maintain and maximize athletes sport performance. However; the effectiveness of different recovery modalities from lactic acid accumulation which is induced by a high intensity exercise is debatable or is not well known.*

Purpose: *Lactic acid is responsible for fatigue or muscle 'cramp' especially after highly intense anaerobic activities and as a result, it lower athletes' performance. Thus, the aim of this study was to investigate the rate of recovery of massage, passive and active recovery on blood lactate removal after maximal all out exercise.*

Methods: *At first fifty-two [52] young male physically fit sports person were purposely selected; however, among those only twenty-four [24] athletes from various sport discipline were found Similar physical and physiological transients in India Sport Authority of Netaji Subhs National Institute of Sport [NIS] Punjab, Patiala. All subjects visited the exercise physiology laboratory in the morning two days before the start of exercise. Using randomization sampling techniques, the 24 Subjects were sub-grouped in to three different categories of 8 athletes in each. All groups were subjected to Maximal all out exercise test on a bicycle Ergometer for 2 continuous Minutes on different days. From each athlete 25 µl of Blood sample was taken following High intensity exercise and then to determine the effectiveness of the modalities the Blood lactate concentration was measured and analyzed by lactate analyzer apparatus after the intervention of the recovery modalities from each athlete.*

Results: *The rate of blood lactate (BL) disappearance is greater in those groups who received active recovery modalities which has a p-value of ($P < 0.05$). However; significant blood lactate reduction was not obtained in either passive or massage treatment groups which has a p-value of ($P > 0.05$).*

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Conclusion: *These findings suggest that active recovery modality is effective for quick lactic acid removal in young age athletes as compared to passive and massage application, though further research implementing larger sample size is required before solid conclusion can be reached.*

1. INTRODUCTION

It is common practice to observe athletes while cooling down their body, in various ways, when they temporarily withdrawal from intense exercise bouts or competition in order to remove the accumulation of lactic acid from their muscle and blood. The benefits of recovery modalities from lactic acid accumulation such as massage, passive and active recovery on subsequent performances in short duration, high intensity exercise has been well documented (Ainsworth et al., 1993; Stanley et al., 1988), however; due to knowledge variation, experience and belief many athletes and coaches do not have the same practice rather they followed and apply different techniques or modalities for blood lactate removal.

Lactic acid is the incomplete breakdown of glycogen." This occurs during periods of activity lasting approximately 90 seconds, but ranges from 15 seconds to 2 minutes. During low intensity exercise your body is supplying enough oxygen to your muscles to easily clear pyruvic acid and lactate produced when you increase your speed to a moderate or hard pace, your energy demands increase. The more intensely you exercise, the hotter the glycolysis fires burn, when glycolysis starts to heat up and produce a lot of pyruvate, the pyruvate starts to 'pile up' and as a result more and more lactate is produced. This is because during high intensity exercise, glycolysis speeds up and pyruvic acid is produced at an increasing rate. When it can no longer be processed through the Krebs cycle as quickly as it is generated, some of the pyruvic acid is converted to lactic acid, which rapidly dissociates into a lactate anion and a free hydrogen ion (H^+). Lactate can then be quickly transported from the muscle into the blood, where it is circulated throughout the body (Astrand and Rodahl, 1986).

McLoughlin et al., (1991); Robert and Roberges, (1997) described that high intensity exercise results in increased levels of both intramuscular and circulating levels of lactate. In most case lactate can be formed in different conditions such as when a decrease lactate removal rate occur, during an increased fast-twitch motor unit recruitment; imbalance between glycolysis and mitochondria respiration, and also at the time of ischemia (low blood flow) or hypoxia (low oxygen content in blood).

Accumulation of lactic acid in the blood and muscle cause muscular fatigue, most researchers also agree that low muscle and blood P^H is a major limiter of performance. The changes of muscle and blood lactate P^H value adversely affect energy production and muscle contraction. An intracellular P^H below 6.9 inhibits the action of phosphofructokinase (PFK) an important glycolytic enzyme, slowing the rate of glycolysis and ATP production. At a P^H of 6.4 the influence of H^+ stops any further glycogen breakdown causing a rapid decrease in ATP and ultimately exhaustion. In addition, H^+ may displace calcium within the fiber, interfering with the coupling of actin-myosin cross-bridges and decreasing the muscle's contractive force (Wilmore & Costill, 1999).

From physiological perspective quick recovery from high intense exercise has many significant to the athletes. It re-synthesize ATP and CP, re-synthesize lactate to glycogen (Cori cycle), oxidize lactate in energy metabolism, restore oxygen to blood, thermo genic effects of elevated core temperature, thermo genic effects of hormones, particularly the catecholamine's, epinephrine and norepinephrine, effects of elevated heart rate, ventilation, and other elevated levels of physiological function (Mc Ardle, et al. 1996; Brookes,1986; Fox and Mathews 1976).

In sports such as basketball, gymnastics, soccer, and any other activities a performer pushed to a high level of anaerobic metabolism may not fully recovery during brief rest periods. Therefore, application of recovery modalities are indispensable.

Even though quick recovery from blood and muscle lactic acid accumulation has significance role, the exact recovery period from lactic acid accumulation is not well documented. Studies have used recovery periods ranging in length from 30 seconds to 40 minutes and the majority of investigations appear to have used recovery periods in excess of 5 minutes. However, the literature is equivocal with regard to whether lactate reduction under certain circumstances results in improved performance (Connolly, D.A., and et.al. 2003).

Active recovery (AR), is fundamentally different from passive recovery (PR), in its approach. while PR would be considered sitting, lying prone or supine, or even just sanding, AR, is usually light jogging or walking or, bicycling i.e. 50 % of maximal aerobic speed, (Thiriet, P., Gozal, D .et. al. 1993). In a study conducted on the effect of active and passive recovery on blood lactate levels after a series of exhaustive sprint bouts, has shown that the blood lactate removal rate is faster when the subjects perform exercise during recovery than when they rest. Edward L. Fox and Donald K. Mathews (1976); Issekut Z et al, (1976) and Poortmans et al, (1978) explained that lactic acid can be removed from blood and muscle more rapidly following heavy to maximal exercise by performing light exercise rather than by resting throughout the recovery period. Such a recovery is referring to as exercise-recovery and is similar to warm-down exercise. of the lactic acid oxidized by muscle is thought to occur within slow-twitch rather than fast-twitch fibers. These are the major reasons why lactic acid removal is faster during exercise-recovery than during rest-recovery. For example, in the former, both the blood flow carrying lactic acid to the muscles and the metabolic rate of the active muscles are greatly increased. In addition, the type of exercise used during most exercise recoveries preferentially recruits slow-twitch fibers to perform the work. This is one of the reasons why recovery from heavy physical activity is faster if the individual jogs or warm down than if he rests completely.

The physiological benefits of massage is also well stated. Advocate of massage therapist explained that massage helps your muscles recover is via the enhanced removal of lactic acid and promotes the release of lactic acid from the tissue. In addition, massage actively increases the rate of blood flow to and from the area. They further showed that massage increase local circulation, increase cellular permeability (thus enabling easier passage of lactic acid out of muscle cells), and a shooting effect on central and peripheral nerves. Especially Swedish massage causes the pores in the tissue membranes to open facilitating the exchanges of fluids. This improves the removal of waste products such as lactic acid allowing muscle to absorb the very rich oxygenated blood.

Studies like (Starkey, 1993; Camberlain, 1982; Hutson, 1996; Clews, 1996; Anderson and Hall, 1995; Ljungfert et al, (1994), Caafarelli and Flint, 1993; Mellion, 1994; and Dunn R. 1996) clearly showed that massage has a number of benefits, it increased blood flow, increased lymphatic drainage, neural stimulation, and encouragement of venous return, relief of pain, injury rehabilitation and relaxation etc. However; studies on the effect of massage on lactate disappearance is equivocal. Dolgener and Morien (1993) study on the effect of massage, on lactate disappearance following short-term exhaustive work discovered that following maximal all out Exercise massage did not remove lactate better than passive recovery or as well as active recovery (cycling at 40% of VO_2 max). Guptas, et al, (1996) supported the above-mentioned study, in explaining that, the ability of massage to remove muscle “toxins” or lactic acid has been demonstrated by human studies that massage has no influence on post exercise blood lactate clearance, while mild exercise can significantly speed up its removal.

On the other hand, (Wasserman, K., et al, 1986)**,** elucidated that massage can help remove the lactic acid and other metabolic waste products from the cells and also increased *tissue permeability* especially, deep massage causes the pores in tissue membranes to open, enabling fluids and nutrients to pass through. This helps remove waste products such as lactic acid and encourage the muscles to take up oxygen and nutrients which help them recover quicker. The aim of the present study, therefore, was to investigate the rate of recovery of massage, passive and active recovery on blood lactate removal after maximal all out exercise, in selected young male sports person. It was hypothesized that active recovery is an effective means of lactic acid removal from the muscle and blood, then either massage or passive recovery after a high intensity short duration bicycle ergo meter.

2. METHODS

2.1 RESEARCH DESIGN

The before-and-after blood lactate measure design was used in this research study. The testing protocol was identical in all the three groups within the testing session.

2.2 Subjects

Twenty-four (24) healthy non-smoking male sports men from different sport discipline (age 23.66±3.36 years, mass 62.52 ±10.97 kgs; height 177.3±3.4cm volunteered to participate in this study. All subjects completed a health history questionnaire and signed an informed consent prior to participation. All subjects were from various sport discipline such as basketball, gymnastics, box and wrestlers. All procedures were approved prior to testing by the India sport Authority of Netaji Subhas National Institute of Sports (NIS) Review Committee for the Use of Human Subjects at the institution. Subjects were randomly divided into three groups similar in age, height and body mass.

2.3 Experimental Protocol

Before subjects underwent to the recovery modalities protocol all subjects instructed to visit the exercise physiology laboratory for the purpose of general familiarization. At the first day, general familiarization was held; to ensure that they all knew the protocol and could complete the amount of work required. During familiarization time subjects were instructed to maintain their normal diet on the day before the test.

It was also recommended that subjects were asked not to exercise on the day of the test, avoid ingestion of food and caffeine for three hours before the exercise. . Basic safety massage tips also given such as: to remove jeweler, glasses and contact lenses, not to eat for two hours before massage, not to drink alcohol or non-prescription drug and been to the toilet beforehand. Prior to massage some contra-indications were assessed by looking the body of the subject with shorts, such as infectious disease including skin disease, a fever, an acute inflammation or phlebitis, recent undergone surgery or any fractures or open wound or bleeding etc., and verbally subjects were asked whether they experience a serious health problem such as heart disease or thrombosis etc., after all this and familiarizations period, the subjects reentered to the experimental phase.

The order of tests was non-randomized and both protocols were identical except for the recovery Procedure. The exercise protocol starting with a four-minute warm up exercise against 1kg resistance at 80rpm which equivalent to 45% to 50% $\dot{V}O_2max$ on the bicycle ergo meter, this pedaled lightly constituted the reference phase, which creates psychological and physiological readiness for the subsequent all-out exercise period. At the end of the warming-up, subjects started the all-out exercise bout when they received a signal command 3, 2, 1 & Go! During this time subjects were verbally encouraged and motivated to perform the testing portion of the experiment at their maximal physical limits of exertion for 2-minutes. The test was designed to measure lactic acid removal rate after the application of the modalities.

Heart rate was constantly monitored throughout the test and recorded by the heart rate utility system (Spot tester; S-810, Polar electro, Finland). The bicycle ergo meter was initially calibrated as 2 watts for the purpose of warm-up and then changed to 5 watt per body weight during the remaining maximal all out exercise.

2.4 Blood Sampling Procedure:

All blood samples were taken via a standard hygienic finger puncture method by experienced health personnel. Twenty-five (25µl) micro liters of blood were taken for each sample. Such blood samples were collected twice through the experiments procedure and analyzed with Accusport portable lactate analyzer (Boehringer Mannheim, Indianapolis, IN, USA). The first sample was obtained immediately at the end of the exercise bout (2-minute) plus addition of another 3-4 minutes in order to give time for lactate diffusion from intramuscular to the blood plasma. The second blood sample was drawn after the application of the recovery modalities. A 5-minuts period was given for passive and active recovery while for massage recovery group's 15-minutes was taken. Subjects received the administration of the modalities on different days.

In the case of the passive recovery (1st group), the experiment was taken in one day of two session, (morning and afternoon). At the end of the exercise period subjects were told to lie down in a relaxed supine position for 5-minutes on the mat. This type of passive recovery was selected purposively to maximize the normal blood kinetics and to prevent venous blood pool in the lower extremities and also to facilitate the blood lactate removal rate. During active recovery, subjects pedalled with a low intensity (40% to 45% of $\dot{V}O_2max$) at 80rpm with 1kg resistance for 5- minutes (Ainsworth et al., 1993). This procedure took two different days with the same comfortable room temperature. In the 3rd group of athletes, lower limb body massage was carried out by a qualified massage therapist along with an assistant, which consisted of 15 minutes routines encompassing both legs simultaneously. To ensure standardization of time a stopwatch was used. The selected routine was designed to target the main muscles or active muscle groups used in driving the bicycle ergometer. Deep effleurage and petrissage massage techniques were used. Effleurage massage consisted 8 minutes (4-minute in supine and 4-minute in prone position) of rhythmic pressure stroke along the longitudinal axis of each muscle group in a distal to proximal fashion. Petrissage, which lasted for 7 minutes (3- and half minute in supine and the remaining 3- and half in prone position), consisted of kneading and squeezing motions over the muscle mass. The sequence of application of massage in both position (supine and prone) position was as follow: starting with effleurage (2-minutes) followed by petrissage (3-and half minute) and finished by effleurage (2-minutes). While subjects were receiving massage they first lying in prone position followed by supine position. Olive massage oil was selected for this purpose. This procedure took three different days with the same comfortable room temperature.

3. STATISTICAL CONSIDERATIONS

For adequate interpretation, the present data has been processed using analysis of variance (SPSS, version 17). Alpha was set at $p<0.05$ for all analyses. One-way ANOVA (analysis of variance) followed by post hoc test: Tukey's Multiple Range Test is used. 1. ANOVA_ is used to compare more than two mean scores. The purpose of one-way ANOVA is to compare two or more means on the effect of one independent variable. Comparing the groups in pairs i.e. group one with group two, group one and group three. 2. Test of significance (Post hoc test) – is another statistical test which required identifying the difference when 'F' is significant. This test is applied to determine whether the obtained differences between three sample means X1, X2, and X3 are indicative of a real difference or if it is due to the random sampling error 3. A multiple comparison test – this test used to compare each group mean with every other group mean. 4. Standard Error of Mean (SEM) – it indicates the average dispersion that will be anticipated in the arithmetic mean 5. Mean (X) – Arithmetic mean is calculated by adding up all the observation and dividing the sum by the number of individuals. 6. Standard Deviation ( ) – it measures the absolute dispersion of variability.

No	Subjects	Age	Weight	BLC In(mm/L)		Δ	RHR	MHR	IL	FL
				After Exercise	After Modality					
1	Subj-1	33	74	12.56	11.98	0.58	72	172	140	280
2	Subj-2	23	79	12.34	9.23	3.11	85	182	160	360
3	Subj-3	30	65	12.26	10.01	2.25	80	178	120	260
4	Subj-4	25	70	10.06	8.00	2.06	83	180	140	315
5	Subj-5	27	60	11.53	8.96	2.57	78	168	120	270
6	Subj-6	24	77	10.79	8.76	2.03	94	176	140	315
7	Subj-7	23	64	10.57	9.10	1.47	93	188	120	265
8	Subj-8	26	67	10.59	9.64	0.95	82	185	120	260
	Mean	23.44	61.78	11.34	9.46	1.67	74.11	158.78	117.7	258.33
	S.D.	3.543	6.697	0.961	1.179	0.83	7.366	6.610	14.880	35.999

4. RESULTS

Lactate data are reported in mmol· l^{-1}.

Table-1– Passive Recovery Modality

KEY : 1 .RHR- resting heart rate; 2. MHR- maximum heart rate; 3 IL-initial load; FL-final load; Δ- blood lactate concentration difference

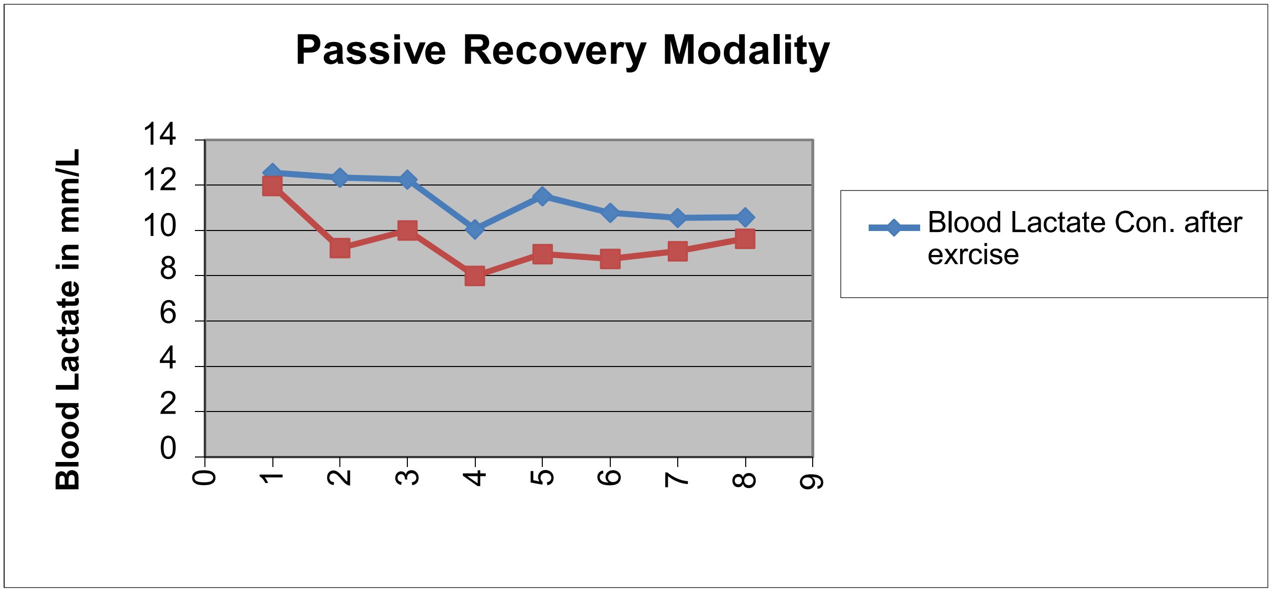


Table-2 – Active Recovery Modality

No	Subjects	Age	Weight in Kg	BLC In (mm/L)		Δ	RHR	MHR	IL	FL
				After Exercise	After Modality					
1	Subj-1	29	72	11.68	5.15	6.53	69	182	140	300
2	Subj-2	30	62	6.16	2.50	3.66	86	155	120	240
3	Subj-3	23	67	10.33	6.25	4.08	78	184	140	280
4	Subj-4	30	98	8.91	4.76	4.15	78	174	180	300
5	Subj-4	23	62	8.13	2.57	5.56	67	177	120	240
6	Subj-5	23	64	9.12	3.25	5.87	77	170	120	240
7	Subj-5	29	67	8.16	4.36	3.80	74	172	120	240
8	Subj-6	24	59	9.29	4.74	4.55	78	168	120	240
	Mean	23.44	61.22	8.97	4.2	4.24	67.44	153.56	117.78	231.11
	S.D.	3.377	12.426	1.629	1.319	1.069	5.938	9.082	21.213	28.284

KEY : 1 .RHR- resting heart rate; 2. MHR- maximum heart rate; 3 IL-initial load; FL-final load; Δ- blood lactate concentration difference

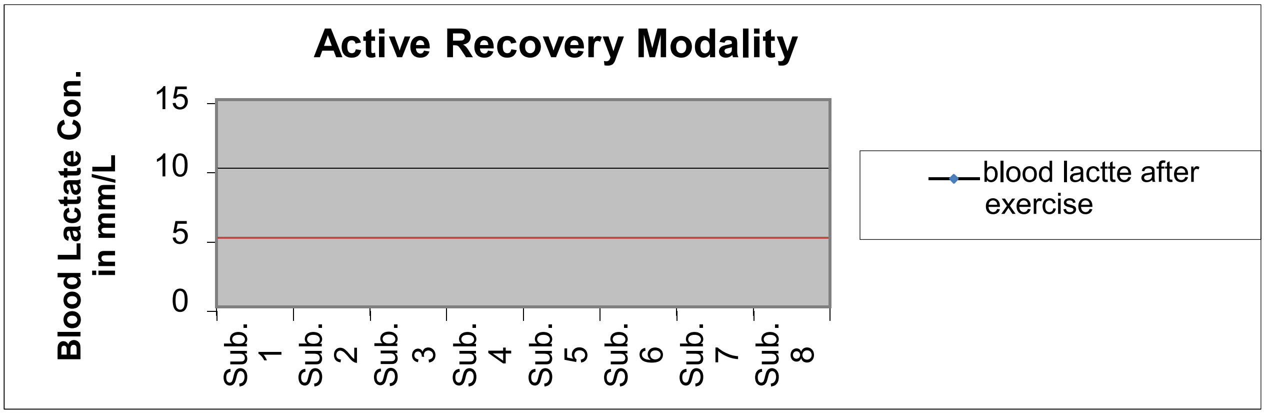
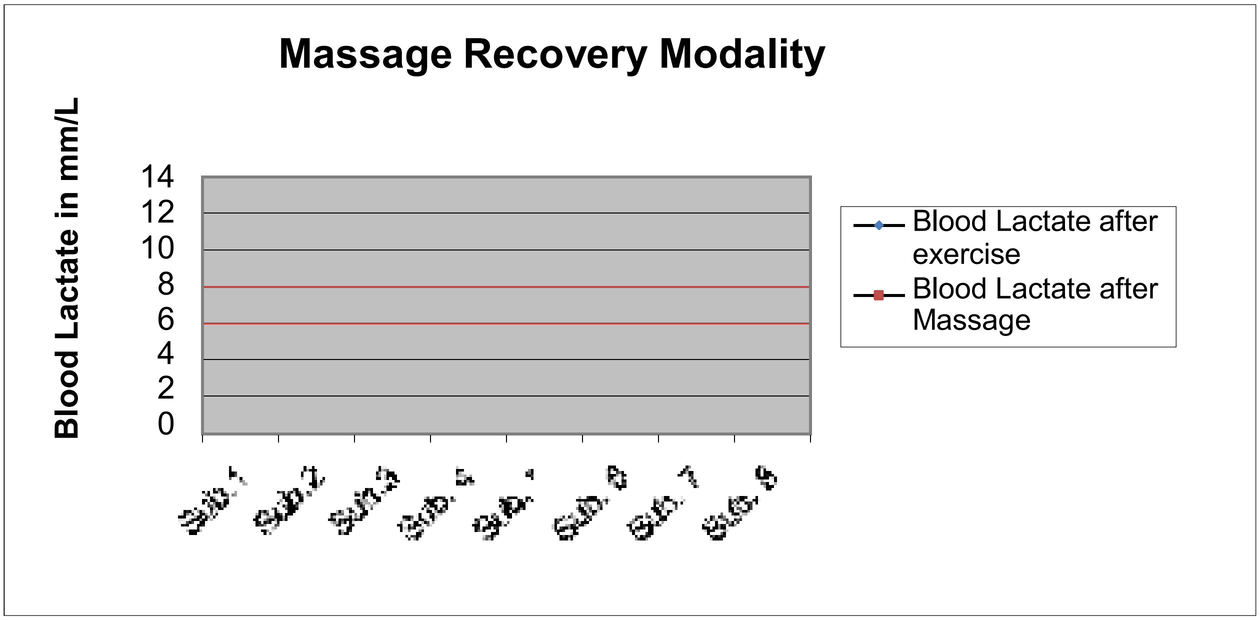


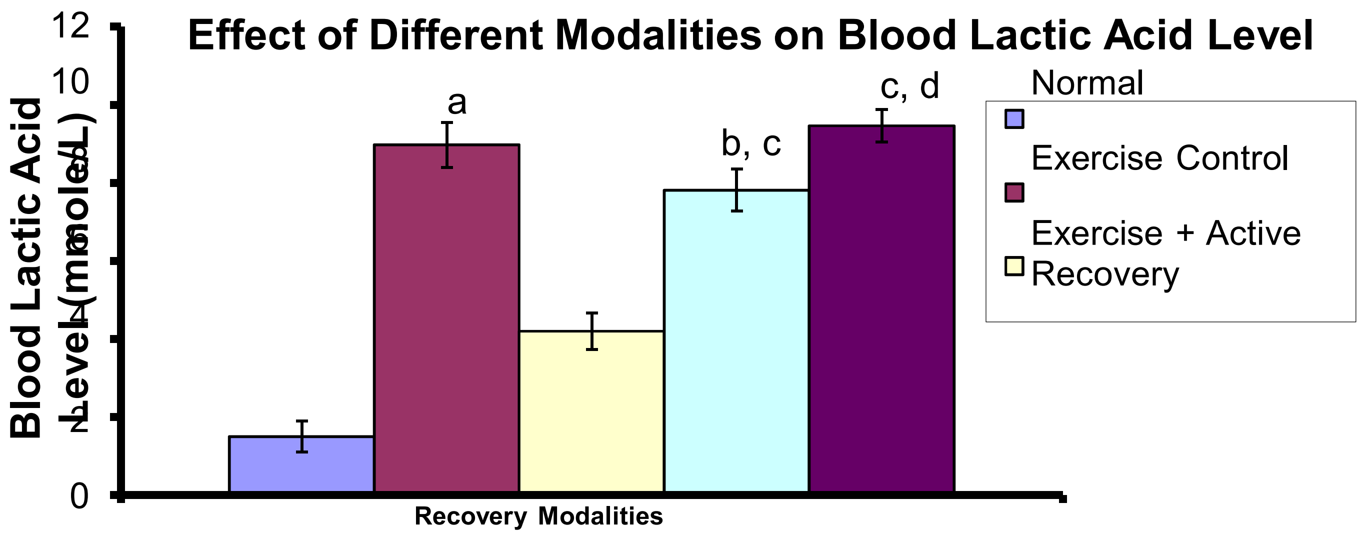
Table-3 – Massage Modality

No	Subjects	Age	Weight	BLC (mm/L)		Δ	RHR	MHR	IL	FL
				After Exercise	After Modality					
1	Subj-1	23	74	9.05	7.89	1.16	78	154	140	280
2	Subj-2	27	60	9.54	9.18	0.36	76	195	120	240
3	Subj-3	31	70	11.41	8.07	3.34	88	178	140	280
4	Subj-4	22	62	11.58	7.78	3.80	65	178	120	240
5	Subj-5	28	59	8.85	6.16	2.69	92	177	120	240
6	Subj-6	30	101	7.25	5.04	2.21	79	167	150	350
7	Subj-7	27	80	10.16	8.90	1.26	90	197	160	320
8	Subj-8	29	75	10.25	9.49	0.76	92	172	140	260
	Mean	24.11	64.56	9.76	7.81	1.73	73.33	157.56	121.11	245.56
	S.D.	3.181	13.793	1.420	1.528	1.254	9.621	14.038	15.059	40.686

KEY : 1 .RHR- resting heart rate; 2. MHR- maximum heart rate; 3 IL-initial load; FL-final load; Δ- blood lactate concentration difference



Summary of the Three Modalities



5. DISCUSSION

The present study focused on the effectiveness of active, passive, and massages recovery modalities on the removal of lactate following maximal all out exercise in sports persons.

From the above results it was observed that significant higher amount of lactate were removed in the group that received active recovery has compared with the two other groups which received passive recovery and massage recovery modality ($P<0.01$).

This is an agreement with the study observed on the effect of active and passive recovery on blood lactate level after a series of exhaustive sprint bouts showed that; blood lactate removal rate is faster when subjects perform exercise during recovery than when they rest during recovery (Jack H. Wilmore and David L. Costil, 1999). A study conducted on the effect of active versus passive recovery modality on lactate disappearance elaborated further by (Jack H. Wilmore and David L. Costil, 1999). In this study it was reported that after a series of exhaustive sprint bouts, the participants either sat quietly (passive recovery) or exercised at an intensity of 50% $\dot{V}O_2$max. It was found that blood lactate was removed more quickly during active recovery than passive recovery. This is due to the actively maintains elevated blood flow through the active muscles which in turns enhance both lactate diffusion out of the muscles and lactate oxidation. In other words, this shows that the facilitated removal of lactate with recovery exercise likely is the results of an increased perfusion of blood through "lactate using" organs such as the liver and heart. In addition to this increased blood flow through the muscles during active recovery it certainly would enhance lactate removal rate; because this tissue can oxidize lactate via Krebs cycle metabolism.

(Fox and Mathews 1976) also reported the significant of active recovery and passive recovery. The study of the result supported the current study as lactic acid can be removed from blood and muscle more rapidly following heavy to maximal exercise by performing light exercise rather than by resting throughout the recovery period. Amazingly (Poortmans et al. 1978) stated that removal of lactate by non-exercising muscle stops soon after the end of the activity. For this reason, recovery from an accumulation of lactate is slower during rest than during light or moderate physical activity. The greatest lactate removal mechanism in the case of active recovery modality is as a result of the distribution of circulating lactate to sites of metabolism such as liver, heart and previously in active muscles (Belcastro and Bonen, 1975). However, others have suggested that lactate is taken up and oxidized by mild to moderately active skeletal muscle during recovery (Brookes GA 1986; Thiriet et al. 1993). This is also observed in the present study. The lactate data in the present clearly reveal that active recovery modality which constituted continuous 5 minutes cycling approximately at the rate of 30% to 40% V O2 max is result the best means of modality than the remaining two. The optimum recovery exercise intensity that produces the fastest rate of removal of blood lactic acid has been calculated to between 30% and 45% of V O2 max ; but the types of ergo meter used (bicycle or treadmill) and also the nature of the subjects (either athletes or non-athletes) can alter the value of oxygen consumption (□ V O2 max) (Fox and Mathew, 1976). Mc Ardle et al. 1996 stated that the optimal level of recovery by exercise on bicycle ergo meter is between 29% to 45% of □ V O2 max and 55% to 60% □ V O2 max when the recovery involves treadmill running. This optimum range of exercise recovery is an evident to the effectiveness of the present study, exercising on the bicycle ergo meter. Massage versus passive recovery is depicted and compared on Table 2B. From the data of the present study it was observed that no significant difference existed in the lactate disappearance rates between the two modalities. In other words massage does not seem enhance or alter lactate disappearance kinetics. Different study on the effective of massage in removing lactic acid has produced equivocal findings in recent years. For instance (Goats 1994) demonstrated that blood is the medium by which most of the oxygen, carbon dioxide, glucose, free fatty acids, hormones, and thermal energy are transported, thus anything that alter blood flow will have an effect on the rate at which this substance will be delivered and removed. Along with this study a radioisotope showed that moderate exercise was a less efficient way to improve blood flow enlarge muscle group than tapotement. Some athletes and physiotherapists support claims that massage can aid recovery and optimize performance; but the literature on the role of massage increasing blood flow or lactate clearance is equivocal (Modedero J, Donne B. 2000) raising a question as to the precise role of massage in short term recovery. However; a study conducted and reported by (Dolgener and Morien 1993) supported the present findings, in that massage following exercise did not remove lactic acid better than active recovery cycling at 40% of V O2 max/ The ability of a massage to remove "toxins" or lactic acid and other metabolic waste products from the cell was also reported in some other study. According to the study report massage increased tissue permeability especially deep massage cause the pores in tissue membranes to open, enabling fluids and nutrients to pass through. This helps remove waste products such as lactic acid and encouraging the muscle to take up oxygen and nutrients which help them to recover quickly. The main emphasis for an effective of massage in recovery from exercise was focused on improvement in blood flow and lactate clearance. Research in the field of sports massage has been flawed by many methodological variations and poor experimental control during the test phase including: inconsistent massage duration, no standardization of warm-up etc. but in a practical setting massage could show performance improvements, but lack of control would devalue the results (Cafarelli and Flint 1992).

However, the current study and the study demonstrated by human clearly shows that massage has no significant influence on post exercise blood lactate clearance, while mild exercises can significantly speed-up its removal rate (Guptas et al., 1996).

Some literatures support psychological benefits of massage (Hemmings B, et al 2000) but physiological and performance benefits have never been consistently observed (Tiddus PM, 1997). All these literatures serve as a back bone to the findings of the present study.

6. CONCLUSION

The data results in the present study evident from the t-value matrix and analysis of variance on the effectiveness of the three modalities shows that no significant difference observed between passive and massage recovery modalities but amazingly it was observed a significant difference ($P< 0.01$) in both active and passive recovery modality and also between active and massage recovery in removing lactic acid accumulation from the muscle and the blood.

Therefore, it need to be emphasized that athletes who take on exhausting exercise regiments need to complement the training program with active recovery modality so that they are able to recover quickly and able to take on successive load successfully. This definitely will help the athletes in the quest of Gold.

Thus, from this study it widely acknowledged that lactate removal from short duration all out maximal bicycle ergo meter exercise is enhanced during active recovery than passive and/or massage during the limited 15 minutes of recovery phase.

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