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Research Article

A COMPARISON STUDY ON THE IMPACT OF ACUTE LASER RADIATION WITH TWO DIFFERENT WAVELENGTHS (650 & 830) ON AEROBIC POWER SELECTIVE BLOOD FACTORS IN ENDURANCE ATHLETES

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ABSTRACT
This study aimed to compare the impact of two different laser wavelengths 650 nm and 830 nm onaerobic powerand some physiological factors (accumulation of lactate, hemoglobin, hematocrit). For this purpose, 18 track and field athletes were selected randomly. The subjects were randomly divided into three groups: first group: 650 nm laser with a power of 150 mW (Zalesskaya *et al.,* 2005), second group: 830 nm laser with a power of 120 mW (Zalesskaya *et al.,* 2005), third group: the control group by applying laser off (Zalesskaya *et al.,* 2005). The blood samples of rest state and the state of response to Bruce exhaustive exercise were collected.After a week, the subjects participated in exhaustive test. The blood samples of response to laser were collected again before and after laser and exhaustive tests. The independent one way ANOVA was used for comparison between groups. Also, the Banfroni post hoc test was used in case of results significance.The paired t-test (dependent) was used to assess changes within the groups. The results showed thatlactate accumulation was reduced and aerobic power was increased significantly in second group compared with other two groups.Since the change in wavelengths and doses mayaffect achieving significant results, it is recommended that the wave length of 830 nm to be used rather than 650 nm.

Keywords: *Laser, Aerobic Power, Blood Lactate, Hemoglobin, Hematocrit*

INTRODUCTION
Today, the competition in different sports areas is very important. In addition to potential skills of athletes, a regular exercise, nutritional, and supplemental program may help them achievingthe high levels championship. In general, the sports activities can be divided into two recreational and competitive groups. Also, the competitive sports can be divided into three categories: short-term and high-intensity sports, medium-term and medium-intensitysports, and long-term and low-intensity sports. In the long-term and low-intensity exercise, one of the main factors in the success of athletes is their aerobic power and the factors affecting it. One of the effective methods in improving aerobic power is improvement offactors affecting it such as improvement in ventilation systems and improvement in circulatory systemsuch as better functioning of red blood cells andhigh levels of hemoglobin and hematocrit. Also, the consumption of oxygen by muscles may also be involved in this area (Morimoto *et al.,* 1995; IslamiFarsani *et al.,* 2005; Jansen, 2007). Several training methods have been provided to improve the power. However, these training methods cannot create significant changes in elite athletes. Today, the laser is used as a new method to help normalization and physiologic stimulation infactors such as wound healing through better oxygenation, revascularization, coronary vasodilation (Simunovic, 2000; Oshrio, 1991; Goldman, 2002; Paulo *et al.,* 2006; Passarella *et al.,* 1988), effects on blood hemoglobin (Zalesskaya *et al.,* 2005; Passarella *et al.,* 1988), effect on cellular ATP level (Karu and Pyatibrate, 1995), and effect on blood viscosity (Mi *et al.,* 2004; Karu and Pyatibrate, 1995; Gordon and Surrey, 1960). The laser's physiological effects are created through chemical and biochemical components within cells which are stimulated with photons of laser and are known as Photo acceptor (Simunovic, 2000; IslamiFarsani *et al.,* 2005). In this context, the cells produce amplified responses to energy of photon. Klima (1987)

showed that the white blood cells can produce wavelengths 480, 570, 633, 700, 760, 1060, 1270 nanometer during phagocytosis (Klima, 1987). Also, Passarella *et al.*, (1988) showed that the wavelengths 351 and 458 nm increase oxygen consumption in isolated rat liver mitochondria (Passarella *et al.*, 1988; Morimoto *et al.*, 1995). On the other hand, the wavelengths 632.8,650,725,602, and 415 nm increasedcellular ATP levels and the wavelength 554 and477 nm had no effect on ATP (Simunovic, 2000; Karu and Pyatibrate, 1995). Xian - Qian and colleagues (2004) examined the effect of laser on blood. The results showed that the viscosity and sedimentation of blood reduced and deformabilityof red blood cells increased (Mi *et al.*, 2004). The radiation of laser on blood is called photohemotherapy. It is conducted in two methods: intravenous with wavelength 632.8 nm, through the skin over the vein with wavelengths (670,630) and (1300, 800) nm. The radiation through the skin on the cubital vein has higher priority, because it is noninvasive (IslamiFarsani *et al.*, 2005). According to the research on amateur athletes, the main reason of decrease in aerobic power is the reduced oxygen consumption by the muscle cells (Robert and Scott, 2006). After long term exercises and development of muscle compatibility, also, it was found that the reason of aerobic power reduction is reduced delivery of oxygen to tissues by ventilatory and circulatory systems (Robert and Scott, 2006). Considering that there is relationship between aerobic power and lactate accumulation (Jansen, 2007), the research questions are: whether the acute laser radiation with two different wavelengths (650 & 830 nm) may impact on hemoglobin and hematocrit level in endurance athletes?Whether this radiation may change the levels of hemoglobin, hematocrit, and lactate accumulation in endurance athletes in response to Bruce’s exhaustive test?Whether there is difference between these two wavelengths in terms of above variables?

MATERIALS AND METHODS

Methodology

This was a quasi-experimental study. The sample consisted of 18 track and field athletes who had endurance exercise at least for three years. First, the implementation method and purpose of test was explained to subjects. Then, the method of laser work was described and participants were assured about acute laser as a harmless tool; theconsent form was completed and signed. The public information including the name, age, height, weight, and health condition of participantswas recorded in the questionnaire. The subjects were divided randomly into three groups of six members. The first group (650 nm laser): 650 nm laser radiation on elbow’s venous blood circulation for five minutes with 150 mW. The second group (830 nm laser): 830 nm laser radiation on elbow’s venous blood circulation for six minutes and 15 seconds with 120 mW. The third (control) group: applying off laser similar to two groups to control psychological effects. The first group: subjects conducted pretest (including first blood test, Bruce test, second blood test) after 10 minutes of rest in upright position. For this purpose, the first blood sample was obtained to analyze the blood’s lactate, hemoglobin, and hematocrit concentration. The elbow vein was disinfected by alcohol and cotton; then, the blood sample was taken. The collected bloods were kept in special test tubes containing citrate to prevent blood clots. Then, the subjects prepared for Bruce test on treadmill with a five minute warm up and stretching all large muscles. By closing the sensors of analyzer’s gas device, the Bruce test was performed by athletes to their maximum performance level. After the stop of Bruce test, the aerobic power of subjects was recorded. The second blood sample was immediately taken similar to before Bruce test and the results were registered in the records of subjects. It took a week to eliminate the effect of Bruce test in subjects. In the day before laser radiation, the third blood sample was taken. At this point, the athlete’s cubital vein in elbow was washed with alcohol cotton in sitting position. The 650 nm laser was radiated with a power of 150 mW without touch and pressure for five minutes in the area perpendicular to the skin. The fourth blood sampling was conducted in the post-test in the same day. The Bruce test was conducted; then again the fifth blood sample was taken and the results were registered in the records of subjects.

The second group: the pre-test in this group was similar to first group and the results were registered in records.Similar to first group, the test day was considered to be after a week of recovery. First, the blood sampling was conducted. The 830 nm laser was radiated with a power of 120 mW without touch and

pressure for six minutes and 15 seconds in the area perpendicular to the skin. The post-test was conducted in the same day like the first group.
Control group: In this group, the pre-test was done like the two groups. After a week of recovery, the blood sampling was conducted in the test day.
Then, the off laser was applied to control subjects' psychological effects. Then, blood sampling was repeated. The Bruce test was conducted; then again, blood sampling was performed and the results were registered in the records of subjects.
Determining the time required for the radiation of two types of laser:

$$150\frac{mj}{s} \cong 150mw \overset{\text{equal}}{=} \text{The first laser with 650 nm and 150 mw}$$

$T_1 = 5$ min

The time required for radiation of 150 mw to reach 45 Jouledose

$$150mj \times 60 = 9000\frac{mj}{\min} \overset{\text{equal}}{=} 9\frac{joule}{\min}$$

$$45 = 9 \times T_1 \Rightarrow T_1 = \frac{45}{9} \Rightarrow \text{The required dose is 45 joules}$$

$$120\frac{mj}{s} \cong 120mw \overset{\text{equal}}{=} \text{The second laser with 830 nm and 120 mw}$$

$$120mj \times 60 = 7200\frac{mj}{\min} \overset{\text{equal}}{=} 7/2\frac{\text{joule}}{\min}$$

$T_2 = 6/25$ min

6minutes and fifteen seconds time needed for 120mw radiation to reach dose of 45Joule

$$45 = 7/2 \times T_2 \Rightarrow T_2 = \frac{45}{7/2} \Rightarrow \text{The required dose of 45joules}$$

The Kolmogorov - Smirnov test was used to determine the normality of data. The independent one way ANOVA was used to evaluate the impact of different laser wavelengths on measured factors (comparison between groups). Also, the Banfroni post hoc test was used in case of results significance.The paired t-test (dependent) was used to assess changes within the groups. The 0.05 confidence level was considered to accept or reject hypotheses.All statistical calculations was performed using software SPSS (version 22).

RESULTS AND DISCUSSION

Findings

The descriptive information of subjects is shown in below table.

Table 1: General Characteristics of subjects

	The first group (650nm laser)	The second group (830nm laser)	The control group (laser off)
Height (cm)	169.83 ± 14.62	176.16 ± 5.23	173.5 ± 5.54
Weight (kg)	53.11 ± 6.99	68.56± 11.04	57.35 ± 2.8

The following tables show the subjects' blood samples and data of respiratory gases analysis were collected at different stages. In this study, the blood samples were taken five times. Also, Bruce's aerobic power test was conducted twice with an interval of one week. The data of fist and second Bruce exhaustive test forthree groups is shown in following table.

Table 2: The mean and standard deviation of aerobic power (Mg / min / kg)for groups in first and second tests

	The first group (650nm laser)	The second group (830nm laser)	The control group (laser off)
First test	57.18 ± 8.08	57.42 ± 5.59	53.44 ± 2.55
Second test	55.63 ± 1.17	61.06 ± 4.69	53.35 ± 4.44

The data of dependent variables in the study was collected in three blood sampling times for three groups. They are provided in the following tables.

Table 3: The amount of hemoglobin in three groups in five blood sampling steps

	The first group (650 nm laser)	The second group (830 nm laser)	The control group (laser off)
B1 (first blood sample) before the first test	15.5 ± 1.27	14.6 ± 1.31	14.14 ± 0.98
B2 (second blood sample) after the first test	16.08 ± 1.36	15.31 ± 1.36	15.32 ± 0.67
B3 (third blood sample) before applying laser	15.08 ± 2.3	14.37 ± 2.3	13.76 ± 1.01
B4 (fourth blood sample) before the second test	16.66 ± 3.04	15.1 ± 3.11	15.06 ± 2.67
B5 (fifth blood sample) after second test	16.08 ± 1.4	14.92 ± 1.67	15.75 ± 1.37

Table 4: The amount of hematocrit in three groups in five blood sampling steps

Control group	Second group	First group	
44.36 ± 1.66	43.78 ± 2.19	45.22 ± 2.7	B1
47.72 ± 1.03	46.8 ± 2.19	47.91 ± 2.13	B2
41.13 ± 1.97	43.43 ± 3.62	44.66 ± 5.12	B3
45.2 ± 5.42	49.11 ± 9.23	48.15 ± 6.68	B4
46.46 ± 3.36	50.25 ± 8.12	49.56 ± 6.88	B5

Table 5: The amount of lactate in three groups in five blood sampling steps

Control group	Second group	First group	
36 ± 9.7	40.2± 12.87	35.8 ± 16.18	B1
119.4 ± 3.65	134 ± 8.97	101.4 ± 21.7	B2
37.33 ± 3.72	33.33 ± 4.46	38.33 ± 8.21	B3
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100.33 ± 11.31	97.33 ± 11.18	100.17 ± 11.41	B5

Table 6: ANOVA of dependent variables in the study

Variable	The source of changes	The sum of squares	Mean-square	d	F	P
Hemoglobin concentration	Intergroup	6.527	3.263	2	0.628	0.554
	Within the group	51.990	5.199	10		
Hematocrit	Intergroup	2.292	1.146	2	0.054	0.948
	Within the group	277.408	21.339	13		
Aerobic power	Intergroup	210.682	105.341	2	8.03	0.004
	Within the group	196.767	13.118	15		
Blood lactate	Intergroup	1720.133	860.067	2	3.919	0.049
	Within the group	2633.600	219.467	12		

Discussion

Regarding the relationship between aerobic power and elements such as lactate, hemoglobin, and hematocrit, this study also examined lactate due to impact of laser on factors such as hemoglobin (Simunovic, 2000; Kato *et al.*, 1981; Karu and Andrreichuk, 1995) and increased cellular oxidation (Simunovic, 2000; Karu and Pyatibrate, 1995; Gordon and Surrey, 1960; Kato *et al.*, 1981). In this study, there were no significant impact of acute laser with different wavelengths on concentration of hemoglobin and hematocrit in all groups. These results are consistent with the findings of Xian - Qian *et al.*, (2004), Paulo *et al.*, (2006), and Karandashef (2000). However, these studies did not directly measure the amount of hemoglobin and hematocrit. In the findings of this research, the amount of hemoglobin may change by reducing or increasing the volume of blood plasma (fluid shifts) during practice (West, 1990; Gayton and John, 2006). Since the measured hemoglobin in the findings depends on the number of blood cells per unit volume (assuming constant mean corpuscular hemoglobin), the use of lasers could not change the rest hemoglobin and hematocrit levels (probably due to relationship between hemoglobin and hematocrit concentration). However, the results of acute laser with different wavelengths impact on hemoglobin and hematocrit levels in response to Bruce exhaustive test showed that during exhaustive activities, the fluid shifts occur toward muscle cells (West, 1990; Robert and Scott, 2006; and Gayton and John, 2006). Considering the amount offluid shifts in maximum activities, therefore, there was no significant impact in off laser group compared to two groups receiving laser. This is consistent with the findings of Xian - Qian *et al.*, (2004), Paulo *et al.*, (2006), Karandashef *et al.*, (2000), and Passarella *et al.*, (1988).

However, these studies did not examine the effects of exercise. The results of this study showed that acute laser with different wavelengths impact significantly on aerobic power and lactate accumulation in response to Bruce exhaustive test. This is consistent with the findings of Xian – Qian *et al.*, (2004), Zalskaya *et al.*, (2006), Karandashef (2000), Pasarla *et al.*, (1988), ProfessorLievens *et al.*, Meshalkin and Sergievskiy (1981), Kapshidze *et al.*, (1993), and Passariello *et al.*, (1988). However, these studies also did not examine the effects of exercise. Given that aerobic power can be considered in two transmission and consumption process categories (Robert and Scott, 2006), the factors that can affect aerobic power

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include reduced viscosity, increaseddeformability of red blood cells in transmission process, and increased activity of enzymes involved in oxygen consumption in the process of consumption. On the other hand, the increased aerobic power which can reduce the amount of produced lactate by muscles (Robert and Scott, 2006; Jansen, 2007) is also a good factor in reducing the amount of lactate in response to Bruce exhaustive test.

Conclusion

The results showed that the radiation of 45 J acute laser with 830 nm and power of 120 milliwattson elbow venous blood circulation in second group increased significantly the aerobic power and changed significantly lactate concentration in response to Bruce exhaustive test compared with radiation of 45 J acute laser with 650 nm and power of 150 milliwatts on elbow venous blood circulation in first group and off laser group in control group.

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