THE EFFECT OF PLYOMETRIC TRAINING ON HEMATOLOGICAL PARAMETERS IN ALPINE SKIERS

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Abstract
The aim of this study was to determine and evaluation chronic effects of plyometric training on hematological parameters of the Turkish National Alpine Ski Team athletes during 12-week preparation period. In the study 12 sportsmen volunteers participated whose mean age was 17.50 years. Twelve weeks plyometric training protocol performed to participants. The training program was applied for twelve weeks and five days a week in total 60 training unit. As the program preceded the intensity and content of training increased. Blood samples were taken before and after training program. The Red blood cell (RBC), white blood cell (WBC), Granulocyte (GR), hematocrit (HCT), Hemoglobin (HGB), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) measurement were analyzed blood samples with automatic hematological analyzer (Toshiba Accute PPS TBA-40FR). Wilcoxon Signed Rank test was used in order to compare statistical values of before and after exercise and significance level alpha was set 0,05. Before and after training program values were compared for RBC, WBC, GR, MCV, MCH, MCHC and no significant changes have been observed for these values. However there were significant (p>0.05) increase of HCT and HGB values. We were concluded that as a result of the study twelve week plyometric training program increased the red blood cells and hemoglobin levels and as a result improved oxygen carriage capacity of the Turkish National Alpine Ski Team athletes.

Key words: *Exercise, Oxygen carriage capacity, Blood parameters*

INTRODUCTION

Skiing are diversified into two branch related with performed area as Alpine skiing and Nordic skiing. These disciplines differed from each other as it was happened in each sport branch depending on performing style and physical physiological characteristics of skier.

Alpine skiing competitions and trainings consist of intensive and hard exercises. Measurements taken during activities on snow showed that maximum oxygen consumption was about 90% higher than normal rate and lactate level was higher than 10 mmol/L. (Veicsteinas et al., 1984). When these measurement was considered it was clearly shown that anaerobic metabolism compensate 60 % of the energy needed during alpine skiing competition and trainings (Andrew et al., 2001). The initially four components which is aerobic capacity, anaerobic capacity, movement skills, and flexibility, encompass most aspects of physical training for alpine skiing (Hintermeister & Hagerman, 2000).

Any factor that cause decrease in oxygen carrying capacity to blood also result increase pace of erythrocyte production. Bone marrow produces erythrocyte very fast. Pace of erythrocyte production was determined by the oxygen carrying functions of cells. Factors disturbing lung's oxygen absorption and tissue hypoxia came to erythrocyte production pace (Guyton, 2000).

During the exercise some blood fluids leaves blood vessels and passes through the tissues and the concentration of hematocrit, hemoglobin and plasma proteins increase in blood. Amount of leukocyte also increase very fast with exercise. The reason of this increase is with the high osmotic pressure, passing some amount of water to between tissues (Karacabey et al., 2004).
There are some results about hematologic parameters showed that exercises cause in increased blood volume while others indicated decreased. Unal (1998), after eight weeks of aerobic exercise, it was found significant increases in hemoglobin values.

Another similar study, conducted by Rietjens (2002), to eleven Olympic athletes, reported that was found significant increases in HGB, RBC, HCT, MCV parameters. On the other hand did not change significantly WBC, PLT, MCH and MCHC values.

The changes in hematologic parameters depend on the type of exercise, the intensity and duration. In the literature have been reported that these changes, be impressed with taking blood sample methods, the time of experiments, the type of exercise, subjects' ages, gender, training status, and some environmental conditions (Shephard & Shek 1994; Morgan et al., 2004; Neumayr et al, 2002).

In this study aim, the determination and evaluation the effect of plyometric training program on hematological parameter to national alpine ski team.

MATERIAL AND METHODS

Twelve sportsmen who mean age 17.50 years, mean height 169.33 and mean weight 62.91 kg participated as volunteer in our study. All volunteer members were active sportsman of Turkish National Alpine Ski Team. It was permitted from Turkish Ski Federation for al measurements. Before the study, we received the signed document from al sportsmen about they accepted voluntarily participation of the study. This study was performed according to Helsinki Declaration.

Whole participants do not smoke cigarette and do not drink alcohol. The participants do not have any infections and they not used any drugs. Blood samples were taken before and after training program. The blood samples were taken in Sarıkamış City Center H ospital which was about 2200 m. higher than sea level. Body weight, height, The Red blood cell (RBC), white blood cell (WBC), Granulocyte (GR), hematocrit (HCT), Hemoglobin (HGB), Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH), Mean Corpuscular Hemoglobin Concentration (MCHC) were measured for each blood samples. Measurements were performed with "Toshiba Accutee PPS TBA-40FR" fully automatic hematology analyzer.
$MaxVO^2$ level determined progressive whit shuttle run test (Rambsbottom et al., 1988).

Statistical analysis

Analysis of the data was performed using SPSS statistical package program. The was determined of all data is the arithmetic means, standard deviations and Z score and P value. Wilcoxon Signed-Rank Test was conducted for comparison of before and after exercises values. Statically significant level was set at 0.05 and 0.01.

RESULTS

Table 1. Physical characteristics of the subjects (Mean ±SD).

Variables	N	Before Training Program	After Training Program	Z	P
Age (years)	12	17,50±1.16	---	---	--
Height,(cm)	12	169.33±6.76	----	--	--
Weight (kg)	12	62.91±7.47	61.08±7.26	-2.264	0.024*
$MaxVO^2$ (ml/ kg./min.)	12	56.66±2.29	57.58±2.19	-2.666	0.008*

*: P<0.05

It was seen from table 1, there was significant differences of weight and $MaxVO^2$ measurements (p<0.05).

Table 2: Hematologic parameters before and after training (Mean ±SD).

Variables	Before Training Program	After Training Program	Z	P
RBC (10ł/µL)	5.34±0.32	5.54±0.47	-1.883	0.060
HCT (%)	44.88±3.76	46.23±2.71	-2.394	0.017*
HGB (g/dL)	14.77±1.27	15,33±1.24	-2.277	0.023*
WBC (10ł/µL)	6.75±1.40	7.50±1.71	-1.412	0.158
GR (10ł/µL)	4.03±1.13	4.55±1.23	-1.295	0.195
MCV (fL)	83.72±4.46	83.77±7	-1.693	0.91
MCH (pg)	27.35±1.34	26.91±2.73	-1.418	0.156
MCHC (g/dL)	32.73±1.29	32.55±1.28	0.00	1000

*: P<0.05

It was seen clearly from table 2, there was no significant difference between RBC, WBC, GR, MCV, MCH, MCHC values between before and after training (p>0.05). Although there was significant differences of HCT and HGB measurements (p<0.05).

DISCUSSION

Numerous previous studies have been focused on the effects of training on blood cell count that differs from each other (Martinez et al., 2011; Robach et al., 2006). A study suggested that there were no significant differences in erythrocyte level end of 12 week regular exercise of 14 men and 23 women participants (Yeh et al., 2006). Su et al. (2001) reported that considerable amount of variation in erythrocyte level after 5 weeks training of 16 men and 8 women judoka participants. In spite of we were found out significant increases of HCT and HGB values, the RBC values were insignificant. But the increases of RBC values after the training program was approximately significant level (p=0.06).

A study, reported that there were considerable hematocrit amount of decrease for 16 men and 8 women judoka after 5 weeks training (Su et al., 2001). It was reported that there was a decrease in hematocrit volume for athletes was join into intensive exercises program (Ibis et al., 2010). The reason of increase in hematocrit volume can be explained as depending on hemoconsantration and transferring of high volume hematocrit from splenic circulation to circular circulation (Guyton, 2000). There was significant difference of hemoglobin values between before and after training program. In this study it was shown that higher hematocrit volume related to increase in hemoglobin production rate.

In a study, that investigated of effects of exercises training on leukocyte, showed insignificant differences in leukocyte volume between at the beginning of the 12 week regular exercise and the finish values of 14 men and 23 women participants (Yeh et al., 2006). Banfi et al. (2006) reported that insignificant differences in leukocyte at 19 rugby player between at the beginning of training camp and the finish. Mashiko et al. (2004) showed decrease in leukocyte level for 25 rugby player at the end of training camp period. Also it was shown that anaerobic exercise caused significant increase in leukocyte level. In the same study reported that leukocyte volume turned to basal level 24 hours after the exercise (Ibis et al., 2010). Pedersen and Hoffman (2000) pointed out that intensity, duration and type of exercises have effects on leukocyte end lymphocyte level.

Considering the granulocytes level of the participants, it was find out that insignificant difference between before training and after 12 weeks training period. Granulocyte consists of neutrophils, basophiles and eozinophils. These cells are the part of immune system. They plays an important roles of pathological and inflammation condition (Pedersen and Hoffman, 2000). The reason of insignificant differences in granulocyte volume might be explained as; there could not be any inflammation on muscle tissue due to adaptation capacity of sportsmen. On the other hand exercises generally effects acutely on granulocyte.

It was shown that there were insignificant differences between MCV, MCH and MCHC value which was compose of erythrocyte index. Al the parameters were in average range (Londeann, 1978). Pouramir et al. (2004) indicated that the similar result of their study. The study showed that did not any significant various in erythrocyte volume of 35 men gymnastic before and after 10 week exercise (Pouramir et al., 2004). In various studies that aimed to search acute effects of exercise, was shown that changes in mean erythrocyte volume, mean hemoglobin were not important.

As a result, 12 weeks plyometric training program resulted in increase $MaxVO^2$, hemoglobin and hematocrit volume for alp discipline skier. Nevertheless the increases of RBC values was approximately significant level (p=0,06). On the other hand the training period did not affect other blood parameters. It can be concluded that the training program positively effects O_2 carriage capacity of elite sportsman.

PRACTICAL ASPECTS

The plyometric training not only effects anaerobic capacity and muscle power but also positively affects both oxygen carriage capacity and muscle oxygen using capacity at high altitude. The endurance capacity is not very important for alpine skiers, but because of the endurance skill positive effect on anaerobic capacity, we can recommend to training of plyometric exercise program at hypoxic environment.

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EFEKTI PLIOMETRIJSKOG TRENINGA NA HEMATOLOŠKE PARAMETRE SKIJAŠA

Originalni naučni rad

Sažetak

Cilj ove studije je bio da odredi i evaluira hronične efekte pliometrijskog treninga na hematološke parametre skijaša turskog nacionalnog tima u toku dvanaestosedmičnog pripremnog perioda. U studiji je dobrovoljno učestvovalo 12 sportista uzrasta 17.5 godina. Ispitanici su učestvovali u dvanaest sedmica pliometrijskog treninga, koji su prakticirali 5 puta sedmično u trajanju od 60 minuta po treningu. Intenzitet i trenažni sadržaji su se povećavali tokom sprovođenja programa. Uzorci krvi su prikupljeni prije i nakon sprovedenog programa. Crvene krvne ćelije (RBC), bijele krvne ćelije (WBC), granulociti (GR), hematokrit (HCT), hemoglobin (HGB), prosječan volumen crvenih krvnihćelija (MCV), prosječna masa hemoglobin po ćeliji (MCH) i prosječna koncentracija hemoglobin po ćeliji (MCHC) su analizirani automatskim hematološkim analizatorom (Toshiba Accute PPS TBA-40FR). Wilcoxon-ov Signed Rank test je korišten kako bi se komparirale statističke vrijednosti prije i poslije primjenjenog programa na nivou 0.05. rezultati su pokazali da nije bilo statistički značajnih razlika u kompariranim vrijednostima RBC, WBC, GR, MCV, MCH, MCHC, međutim bilo je statistički značajnog povećanja kod vrijednosti HCT i HGB. Zaključili smo da je, kao rezultat dvanaestosedmičnog pliometrijskog treninga, došlo do povećanja crvenih krvnih ćelija te nivoa hemoglobina, a kao rezultat poboljšanog transportnog kapaciteta skijaša.

Ključne riječi: *vježba, transportni kapacitet oksigena, parametri krvi*

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