



Research Paper

The effect of swimming training on some hematological parameters in diabetic rats

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ABSTRACT

Diabetes Mellitus is the most common endocrine disorder in the growing world. A heterogeneous group that is related to different causes and causes different complications can be defined as a complicated metabolic disorder. It is known that exercise has beneficial effects in the prevention and/or reducing of pathologies associated with diabetes. The aim of this study was to evaluate the effects of regular swimming training on some hematological parameters in type-1 diabetic rats. Thirty-two adult male Wistar albino rats were divided into four equal groups as Control (C), Diabetes (D), Exercise Control (E) and Diabetes+Exercise (DE). All groups were fed with standart rat food during the experiment. The rats in the control group did not receive any treatment, while the D and DE groups were injected ip 60 mg / kg STZ intraperitoneally. The trial continued for four weeks after the onset of diabetes. After the diabetes was formed, 1 hour swimming exercise for 4 weeks, 5 days a week was applied to groups E and DE during the trial period. In blood samples, leukocyte (WBC), erythrocyte (RBC), hemoglobin (HGB), hematocrit (HCT), platelet (PLT) and differential leucocyte count were examined. RBCs, Hb and HTC values were reduced in D group. On the other hand, WBC and platelet count were increased in the same group. We observed RBC count, Hb and Htc levels were higher and WBC count was lower in DE group according to D group. As a result, the present study was observed that regular aerobic exercise improves investigated parameters and demonstrates positive effects.

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INTRODUCTION

Diabetes Mellitus (DM) is an important metabolic disease characterized by insulopenia and hyperglycemia resulting from defects in insulin secretion, action or both. DM can cause serious complications because the pancreas gland cannot produce insulin hormone adequately or the insulin hormone it produces cannot be used effectively (Crespilho et al., 2010). DM causes damage to various organs, dysfunctions and long-term acute and chronic complications (Saito et al., 2006; Valentovic et al., 2006; Cambay, 2011). Besides being a very serious and

progressive disease, it causes acute and chronic complications when not controlled and negatively affects morbidity and mortality, resulting in a great health problem for both individuals and society (Tanrıverdi et al., 2013). Along with rapid changes in lifestyle, DM prevalence is rapidly increasing across all developed and developing populations. The main causes of this increase in DM prevalence are population aging, unhealthy nutrition, obesity and sedentary lifestyles (IDF, 2016).

Physical activity and exercise is important for healthy and

long life. It may affect hematological and biochemical parameters as in many systems. Human physical adaptation to exercise is characterized by adaptation of cardiovascular activity and changes in hematological and biochemical parameters (Crespilho et al., 2010; Kostrycki et al., 2016, Balducci et al. 2019, ADA 2019). Exercise is believed to ameliorate the condition of patients with T2DM. The main purpose of Type 2 DM treatment is to prevent or delay chronic complications of diabetes by optimally maintaining blood glucose, lipid and blood pressure levels. For blood glucose control, lifestyle changes such as exercise and diet are of primary importance. It improves glycemic control, lipid profile, immunity and decreases insulin resistance. On the other hand, physical exercise can also act as a stressor, activating the hypothalamic- pituitary adrenal axis (Hevener et al., 2000; Contarteze et al., 2008; Crespilho et al., 2010). Physical exercise has been considered as one of the cornerstones in the treatment of diabetes mellitus along with nutrition and medication since from the past 100 years ago (Sigal et al., 2004; Thent et al., 2013). Regular physical exercises help to prevent diseases such as cardiovascular disease, type 2 DM and obesity (Stampfer et al., 2000; Hu et al., 2001; Ehiaghe et al., 2013; Ahmad, 2019). Aerobic exercise is a valuable therapeutic strategy for T2DM as it has beneficial effects on physiological parameters and reduces the metabolic risk factors in insulin resistance diabetes mellitus. Several studies have shown the positive effects of aerobic exercise based on different intensities on the improvement of T2DM. Aerobic exercises comprise swimming, cycling, treadmill, walking, rowing, running and jumping rope (Ligtenberg et al., 1997; Thent et al., 2013).

The beneficial effects of exercise on metabolism are well known, but the role of exercise on diabetes is little known and experimental diabetic rats are used as a human model for T2DM. Exercise training programs were alternative therapeutic regimens for both type 1 and T2DM (Thent et al., 2013). Because of this reason, in the present study, we evaluated the beneficial and preventive effects of swimming exercise on some hematological parameters in streptozotocin (STZ)- induced diabetic rats.

MATERIALS AND METHODS

Animals and treatment

In the present study, 32 healthy male Wistar Albino rats with average weight of 280 ± 20 g and aged 70-80 days were used. Rats were obtained from the Laboratory Animal Breeding Unit of Necmettin Erbakan University. The research project and animal housing conditions were approved by the Necmettin Erbakan University

Experimental Medicine Research and Application Center Ethics Committee for Animal Studies (2014-042). The rats were housed in plastic rat cages in the experimental animal unit at $23 \pm 2^\circ\text{C}$ at room temperature and in a $50 \pm 10\%$ humidified environment at a 12/12 night/day light cycle and they were fed *ad-libitum* with a standard rat diet. Rats were provided *ad libitum* access to water (~ 50 ml/day/rat) to be refreshed daily for four weeks.

Experimental animals were divided into four equal groups as Control (C), Diabetes (D), Exercise (E) and Diabetes+Exercise (DE).

Induction of diabetes

STZ (60 mg/kg, live weight (Sigma S0130-1G)) was injected intraperitoneal to the D and DE groups as a single dose (Akbarzadeh et al., 2007; Maciel et al., 2013). Group E and Group DE trained 5 d/wk for 4 weeks. The solution of STZ was prepared: 60 mg/kg of STZ (Sigma S0130-1G) were dissolved in 0.1 M citrate buffer (pH 4.5) before application. Seventy two hours after STZ injection blood glucose levels was measured from the tail by blood glucose meters (plusMED). Rats with a fasting blood glucose level of 250 mg/dl and above were considered diabetic. At the end of the 4 week trial period, blood samples were taken under anesthesia and collected by cardiac puncture, and transferred into anticoagulant tubes for determination.

Swimming training protocol

Swimming training program began after induction of diabetes. Swimming exercise was performed in the swimming tank (100x60 cm). The swimming trained groups swam 1h a day, 5 days a week for 4 weeks ($32 \pm 1^\circ\text{C}$). Animals were gently dried with towels after exercise and placed in the cages.

Hematological analyses

In blood samples, leukocyte (WBC), erythrocyte (RBC), hemoglobin (HGB), hematocrit (HCT), platelet (PLT) and differential leucocyte count were determined. Hematological parameters were measured with Auto Hematology Analyzer (Mindray BC800).

Statistical analyses

Statistical differences among the groups were tested by analysis of variance (ANOVA), followed by Duncan's test

using SPSS for windows version 16.0. Significant was considered as $p < 0.05$.

RESULTS

In this study, the effect of swimming exercise on some hematological parameters in streptozotocin (STZ)-induced diabetic rats are summarized in Tables 1 and 2. Diabetes reduced RBCs, Hb and HTC values and significantly ($p < 0.05$) increased WBC count and platelet in D group. RBC count, Hb and Htc levels in the DE group was higher and total WBC count reduced than D group (Table 1)

Diabetic group showed significant increase in lymphocyte count and decreased in neutrophile count as compared with the other groups (especially E and DE Group) (Table 2).

DISCUSSION

Regular exercise is very important to prevent or treat many chronic diseases and their complications (Eljvogels and Thompson, 2015; Kostrycki et al., 2016). Diabetes mellitus is a chronic endocrine disorder, and it needs definite treatment. Many researches have shown that exercise plays a crucial role in improving T2DM. Exercise not only improves the glycemic control, but it can also improve the insulin sensitivity and reverse the diabetes associated complications such as cardiovascular damage, which is considered to be one of the major complications (Thent et al., 2013; Momma et al., 2019).

Aerobic exercise improves the physiological parameters, including glycemic control, fasting blood-glucose level and lipid profile. Daily swimming training can be beneficial effects on some biochemical and hematological parameters in diabetes (Stewart, 2002; Thent et al., 2013). Some studies showed that exercise activities have significantly improved hematocrit, hemoglobin and the number of red blood cells (RBC) in pregnant women, athletes, patients with type 2 diabetes, and streptozotocin induced diabetic.

Ghisai et al. (2014) reported decreased number of leukocytes and increased percentage of neutrophils in exercise treated diabetic rats, while Chrespilo et al. (2010) reported that there was no significant change in both total leukocyte counts and leukocyte counts in exercise- induced diabetic rats. On the other hand, Nazıroğlu et al. (2004) reported a significant increase in leukocyte count in exercise treated diabetic rats when compared with diabetic group.

Sugiura et al. (2000) have reported that chronic exercise training improves the macrophage and lymphocyte function. In this study, the increase in leukocyte count in

exercised group is similar to the other results found in various studies (Chrespilo et al., 2010; Chaar et al., 2011). Chaar et al. (2011) reported an increase in the leukocyte count due to mobilization of leukocytes and inflammatory responses which occur as a consequence of exercise. In this study, the increase in the number of neutrophils and monocytes in total leukocyte count was observed only in exercise group. McFarlin et al. (2003) have reported that leukocyte count was increased after exercise and remained the same for two hours. But Chrespilo et al. (2010) reported no differences between diabetic and exercise groups. On the other hand, some researchers reported an increase in lymphocyte, NK, T and B cell counts after exercise. Also Neves et al. (2015) and Kostrycki et al. (2016) reported that increase in leukocyte count is depended on the duration and intensity of exercise. Chrespilo et al. (2010) have observed that exercise affects opposite in increasing neutrophile count in diabetes. Eosinophile count may variate under stress. The increase in total leukocyte count in experimental diabetes may be due to an increase in free radicals, a decrease in antioxidant activity, and an increase in inflammatory cytokines.

In animals and humans diabetic's, an increase in the number of neutrophils has been observed with a relative decrease in lymphocyte rates in the leukocyte types (Kozlov et al., 1995; Mahmoud, 2013; Keskin et al., 2016). Kozlov et al. (1995) reported moderate neutrophilic leukocytosis and prolonged circulation times of neutrophils and monocytes in diabetic mice and suggested that count may also show low-grade inflammation. But in this study, neither lymphocyte nor neutrophil ratios were significantly changed. The results of the present study are in line with the last literatures. Also in some study, an increase in the rate of lymphocyte in leukocyte types has been reported in diabetic animals (Nikseresht et al., 2013).

It is well known that anemia occurred in chronic diseases. Increased lipid peroxide production and membrane protein oxidation in diabetes causes hemolysis of RBC resulting from hyperglycemia (Nazıroğlu and Butterworth, 2005; Oyedemi et al., 2011; Donmez et al., 2012; Keskin et al., 2016). Also, the observed parallel reductions in RBCs, Hb and HTC values in diabetic animals group in the present study is in line with the results obtained in previous researches Nikseresht et al., 2013; Colak et al., 2014; Keskin et al., 2016). The increases in leukocyte and platelet counts with diabetes are in line with studies conducted in this regard (Nazıroğlu and Butterworth, 2005).

There were no significant changes in RBC count, Hb and Htc levels between the control and experimental groups and these findings are similar to those of Chaar et al. (2011) and Chrespilo et al's (2010). Also in this study, the RBCs, Hb and Htc count levels in the exercised diabetic group was significant higher than the only in the diabetic group, these

Table1. Some hematological parameters in experimental groups, X± SX.

	C	E	D	DE
WBC(x10 ³ /mm ³)	4.50 ± 0.20 ^c	6.52 ± 0.44 ^b	8.14 ± 0.57 ^a	6.94 ± 0.65 ^{ab}
RBC (x10 ⁶ /mm ³)	8.19 ± 0.17 ^{ab}	8.86 ± 0.10 ^b	6.99 ± 0.50 ^b	7.18 ± 0.61 ^b
Hb (gr/dl)	14.93 ± 0.27 ^{ab}	15.78 ± 0.31 ^a	12.26 ± 0.68 ^c	13.80 ± 0.58 ^b
Htc (%)	48.25 ± 1.02 ^a	50.05 ± 1.55 ^a	36.28 ± 2.52 ^b	48.15 ± 3.26 ^a
Plt (L)	779.83 ± 37.72 ^a	579.66 ± 82.02 ^b	832.66 ± 31.48 ^a	608.16 ± 62.03 ^b

a, b,c; p<0,05.

Table 2. Differential leucocyte counts (%) in experimental groups X± SX.

%	C	E	D	DE
Lymphocyte	70.37 ± 1.19 ^a	39.31 ± 10.13 ^b	73.15 ± 3.76 ^a	57.53 ± 6.21 ^{ab}
Monocyte	3.03 ± 0.70	4.02 ± 2.24	3.69 ± 1.00	6.81 ± 2.57
Neutrophile	24.75 ± 0.97 ^b	53.18 ± 7.59 ^a	21.30 ± 3.22 ^b	33.21 ± 5.41 ^b
Eosinophile	1.08 ± 0.27	1.65 ± 0.66	0.75 ± 0.46	1.04 ± 0.22
Basophile	0.81 ± 0.17	1.78 ± 0.88	1.53 ± 0.18	1.76 ± 0.43

a, b; p<0,05.

levels in the exercise and diabetic group were significant lower than only in the exercise groups. Also there was a slight increase in the levels of last previous parameters when compared between exercise and diabetic group and only diabetic group. Thus the importance between these two groups has not been mentioned. After exercise, significant increase in erythrocyte count may be as a result of hemoconcentration (Naziroglu and Butterworth, 2005).

CONCLUSIONS

In conclusion, the results of the present study showed that the regularly swimming exercise performed in the experimentally diabetic rats with STZ had a positive effect on hematological parameters. Data obtained in this study could be used in the future as a basis to plan the duration, intensity and continuance of exercise as one of the available modalities for treatment of diabetes mellitus.

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