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Investigation of the Therapeutic Effects of Hot Springs Waters Sourced from Afyonkarahisar Region on Experimentally-induced Myocardial infarctus in Rats

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Abstract

Myocardial infarction is an important public health problem in human and animals. In this study, myocardial infarction was induced by intraperitoneally injected isoproterenol hydrochloride in saline solution at a dose of 85 mg/kg body weight for 2 days. After myocardial infarction formation, three animals were exed to collect blood and histopathological specimens. The remaining 32 rats were divided into control and study groups for treatment. In the treatment stage; the control group animals were treated with tap water, while the study group animals were received Süreyya I hot spring mineral water. Clinical, hematological, blood biochemical and histopathological examinations was performed in all the animals before study, after myocardial infarction, and on 1st, 7th, 14th and 21st days after treatment. In terms of T, P and R, there were significant differences ($p < 0.05$) with respect to time periods between control and study groups ($p < 0.05$). WBC, NOTR, MON MCH, HCT ve MCV levels decreased, while RBC, HG, HCT, LENF, MCH and MCHC levels increased following treatmen in both groups. These changes were significant in study group comaper to control. It was also seen that ALT, AST, CK and CRP levels of blood biochemical parameters were significantly increased ($p < 0.05$) after myocardial infarction formation. By begining treatment, TP, ALB and GLU levels increased, whereas ALT, AST, CK and CRP levels decreased, especially on the 21st day of the study in the SG. It was concluded that in the correct temperature and time to use Süreyya I hot spring water as drinking and bathing was very successful in the treatment of myocardial infarction, either itself or along with other medical treatments.

Key words: *Afyonkarahisar, balneotherapy, myocardial infraction, rat,*

Introduction

Myocardial infarction (MI) is an important public health problem in human and animals (1,2), and a leading cause of mortality in both developed and developing countries (3). According to the World Health Organization report, heart disease and stroke will become one of the leading causes of death and disability worldwide by 2020 (4).

Despite important progress in this area, new treatments are still needed to treat myocardial ischemia because current treatment has only a limited effect on survival and annual cost (3). Balneotherapy or hot spring treatment is a treatment method that uses natural therapeutic factors with well-researched and recognized healing properties based on chemical, mechanical and thermal effects on the organism (1,5). Belikova and Indyka (6) report that patients with MI achieved very successful results from their treatments with balneotherapic methods. Similar findings have been reported by researchers (7), who evaluated the effects of balneotherapy in patients who developed cardiovascular disease, chronic heart failure and myocardial infarction, and that balneotherapy contributed to the improvement of diseases by reducing heart oxidative stress. Gapon and Ignatov (8) reported that bicarbonate waters prevent complications in heart diseases by decreasing arterial heart pressure. Barashkova et al. (9) observed in their study on 75 patients with myocardial infarction history that carbon dioxide baths had significant healing effects on MI damage. It has been reported that significant electrical activity improvements have been detected in the treatment of heart disorders frequently encountered in diabetes with balneotherapy methods (10).

This study was carried out to determine the therapeutic efficacy of Süreyya I hot spring water, which has a high bicarbonate and carbon dioxide ratio, in rats with MI.

Materials and Methods

The experimental part of this study was carried out in Afyon Kocatepe University Experimental Animals Application and Research Center according to the Directive of Afyon Kocatepe University Experimental Animals Ethics Committee (AKUHADYEK) and it was referred with the report number 123-18 of the board and was supported by Şuayp Demirel as a Research Project.

Animal Material

In this study, a total of 35 Albino rats at the age of 8 week were used. MI was created by injecting isoproterenol hydrochloride (in saline) intraperitoneally (i.p.) at dose of 85 mg/ kg body weight/ 2 days (11). After myocardial infarction, 3 rats separeted and exited for the collection of blood and histopathological samples. The remaining 32 rats were divided into 2 groups as follows:

1. Control Group (CG): Totally 16 rats in this group were given tap water (1 liter/33 kg body wight) for 21 days per os route. In addition, rats in this group were bathed for 10-15 minutes in a bathtubs with tap water set at 32 ± 3 °C, 2 times a day with an interval of 12 hours. In order to collect blood and histopathological samples, per 4 animals were exited on day of 1, 7, 14 and 21 following treatment period.
2. Study Group (SG): Totally 16 rats in this group were given fresh Süreyya I hot spring water (1 liter/33 kg body wight) for 21 days per os route. In addition, rats in this group were bathed in the same water for 10-15 minutes in a bathtubs at 32 ± 3 °C, 2 times a day with an interval of 12 hours. In order to collect blood and histopathological samples, per 4 animals were exited on day of 1, 7, 14 and 21 following treatment period. In this group, 4 animals were also exited on day of 1, 7, 14 and 21 following treatment period in order to collect blood and histopathological samples.

Caution: In order to prevent direct inhalation of CO_2, which is likely to accumulate on the surface of the hot spring water during these baths, a special mechanism similar to Elizabeth Collar was applied to the animals (Figure 1).

Obtaining Blood and Tissue Samples:

Three animals after the formation of MI, and 4 animals from each group on days 1, 7, 14 and 21 following treatment were euthanized under the anesthesia of ketamine/xylazine (100 mg/kg and 10 mg/kg respectively) and blood and tissue samples were taken (12). Tissue samples were stored at +4 °C and sent to Etlik Veterinary Research and Application Institute Pathology Laboratory for histopathological research in 10% formol solution.

Properties of Süreyya I Spa Spring Water Used in Treatment

Süreyya I hot spring water has a total 4046.8 g in per liter and rich in carbon dioxide, sodium bicarbonate, calcium, magnesiım, fluoride and silicon.

Metod

Clinical Examinations

Body temperatures (T), respiration (R) and heart frequencies (P) were measured in all animals and data were recorded for statistical comparisons.

Hematological Examinations

In blood samples taken for hematological examination; erythrocyte (RBC), total leukocyte (WBC), hematocrit (HCT), hemoglobin (HB), mean corpusculer volume (MCV), mean corpusculer hemoglobin (MHC), mean corpusculer hemoglobin concentration (MCHC), lymphocyte (LENF), neutrophil (Hematological examinations such as NOTR), eosinophil (EOS), monocyte (MON) and basophil (BAS) were measured using Chemray Brand blood count device using commercial test kits.

Blood Biochemical Examinations

C-reactive protein (CRP) measurements in blood biochemical examinations using ELISA readers (ChemWell Chromate 4300 Elisa Reader, Awareness Technology, Inc. Martin Hwy. Palm City, USA) using Elisa kits (Sunred Biological Technology Company Co., Shangai/China), Measurements of alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Creatine kinase (CK), Total Protein (TP), Albumin (ALB) and Glucose (GLU) levels on the Cobas Integra 400 Plus Roche Brand (Roche Diagnostics GmbH, Germany) analyzer it is made.

Histopathological Examinations

After MI was created and on days 1, 7, 14 and 21 following the initiation of treatment, heart tissue samples were taken from ketamine (100mg / kg) / xylazine (10mg / kg) anesthesia from randomly selected animals from the control and study groups (12). The samples taken were sent to the laboratory in 10% formol for histopathological mauens, 5 micron thick sections were taken in the laboratory, the sections were stained with hematoxylin-eosin and examined histopathologically in the light microscope.

Statistical Analysis

Statistical calculations of the groups were made according to the variance analysis (ANOVA) method. Duncan test was used to reveal the importance of intra-group differences in the study group. Statistical analyzes were made using Windows compatible SPSS 18.0 (Inc., Chicago, II, USA) package program. Data were given as mean ± standard error and $p < 0.05$ was considered as important.

Results

Body weights (bw) of the animals were weighed one by one with the help of electronic weighing machine, and it was measured as 309.1 g (min.283.3- max.319.2). After myocarditis formation, the animals were weighed one by one and bw averages of 282.1 g (min.243.2-max.305.3) were determined. It was observed that there was a significant ($p < 0.05$) decrease in terms of their averages. In the weighing on the last day of the treatment, bw average of 282.4 g is in CG animals, and there was a statistically significant difference ($p < 0.05$) determined bw mean as 280.1 g in the SG.

Clinical Findings

The clinical findings recorded for the control and study groups are shown in Table 1. When Table 1 is examined; While there is no significant difference between the groups in terms of T averages with the formation of myocarditis ($p > 0.05$), significant differences ($p < 0.05$) in terms of P and R averages were formed, and the most important increases occurred on the last day of the study.

Hematological Findings

Hematological examination findings of CG and SG animals are shown in Table 2. When this table is examined; It was observed that WBC, NOTR, MON, PLT, HCT, MCH and MCV levels increased significantly ($p < 0.05$) after myocarditis, whereas RBC, HG, LENF and MCHC levels decreased significantly ($p<0.05$). In comparisons between groups and in terms of time period, WBC, NOTR, MON, PLT, HCT, MCH and MCV averaged significantly decreased in both groups ($p < 0.05$). <0.05).

Blood Biochemical Examination Findings

The results of blood biochemical analysis measured within the scope of this study are shown in Table 3. When Table 3 is examined; Among the blood biochemical parameters measured, ALT, AST, CK, CRP, TG, TCHOL and LDL levels increased significantly ($p < 0.05$) before the study in the measurements following myocarditis formation, whereas TP, ALB, GLU and HDL levels were significantly ($p < 0.05$) decreased. After treatment, it was found that TP, ALB, GLU and HDL levels increased while ALT, AST, CK, CRP, TG, TCHOL and LDL levels decreased. It has been observed that these changes are statistically more important ($p < 0.05$) in SG animals than in those of CG animals.

Histopathological Findings

Histopathologically, severe myocarditis has been observed in the heart tissue samples taken from animals created by experimental MI (Figures 2 and 3). After treatment, partial reduction in mononuclear cell count was initially observed in SG animals (Figure 4.5), then recovery began (Figure 6) and an improved heart muscle structure was formed on the 21st day (Figure 7). In the histopathological examination of heart tissue obtained on the 21st day of CG animals treated with tap water, it was observed that the case of myocarditis continues (Figure 8).

Discussion Although, MI is an important disese of human and animals, we can not find any literatures about balneotherapy in animals with MI as well as directly studies in human beings. Therefore, as far as we know the present study will be at first in this area. In our study, bw mean of CG animals were found higher than those of SG. This finding has been found to be compatible with studies reporting that treatment with hot spring waters leads to weight loss by increasing fat burning and reducing intestinal fat intake (13).

In our study, although there was no statistically significant difference in body temperature betwen the groups, it was observed that respiratory and pulsation rates were significantly increased ($p < 0.05$). Indeed, there is no statistically significant difference in body temperature, Dogaru et al. (2018) also complies with the information that the reported balneotherapy causes an increase in skin temperature without causing an increase in body temperature. Similarly, Boarescu et al. (14) reported that the heart rate increased and the respiratory intervals decreased in the rats when administered isoproterenol. With the transition to the treatment period, we found respiratory and cardiac frequencies increased significantly ($p < 0.05$) in SG. Some researchers (15) claimed that balneotherapy increases cardiac output, causes vasodilation in peripheral vessels, causes an increase in the frequency of the heart and, accordingly, respiration. and stimulate the sympathetic nervous system of warm baths, blood pressure. Our findings were also in agreement with

findings reported by researchers (16,17) who reported that balneotherapy caused increases in heart and respiratory frequency.

In our study, it was observed that the levels for WBC, NOTR, PLT, MON, which were detected at a high level after the formation of MI, decreased in SG animals following tharpy with Süreyya I hot spring water as drinking and having a daily bath. As a matter of fact, it has been reported that hot spring waters have an immunosuppressive effect and T lymphocytes in the blood decrease significantly in hyperthermal baths, and hyperthermal water provokes ACTH hormone level and cortisol production (13, 18). In another *in vitro* study (19), spa waters have been reported to reduce T-lymphocyte proliferation and blast transformation in both healthy individuals and those with chronic inflammatory disease. Although the mechanism responsible for these relationships is not fully known, it has been claimed to be mediated by proinflammatory cytokines (20,21).

In addition, it has been reported that Mg deficiency has a pro-inflammatory effect, causing clinical inflammation syndrome, resulting in leukocyte and macrophage activation and overproduction of free radicals (22). Sureyya I hot spring water, which we use for the purpose of treatment in the current study, is also a water rich in magnesium.

In a comparative study with tap water, more significant reduction of C-reactive pritein (CRP), TCHOL and TG levels was detected in patients treated with hot spring water (23). In our study, a decreasing in lipid profile and CRP levels in the SG rats following drinking and having bath supported these researchers' findings. Moreover, a 3-week spa therapy program in obese patients has been found to cause a significant decrease in body weight, body mass index, serum levels of TG, TCHOL and LDL (24). Smilarly, TG, LDL, TCHOL levels decreased and HDL cholesterol levels increased in SG rats which received hot spring water in this study. In addition, it has been reported that Mg, which is abundant in the Sureyya I hot spring source, reduce the fat rate accumulation due to blocking cholesterol intake from bowel (25). However, in a study with drinking water supplemented with Mg and Ca (26), no fat-melting effect was obtained and a decrease in TG levels was not observed. This shows that Mg and Ca are not able to affect fat alone, but other elements contribute to this (27). HCO_3 comes first among these elements and it has been reported that water with rich HCO_3 has a reducing effect on total and LDL cholesterol (28,29). Sureyya I spa spring water used for the purpose of treatment in our study is included in the class of hot spring water with bicarbonate and it is a water with a high HCO_3 concentration. As a matter of fact, the lowest TCHOL, LDL and TG levels were obtained in the animals in the SG.

In our study, it was found that AST, ALT and CK levels measured were high in measurements following MI formation, whereas TP, ALB and GLU levels were low. With the onset of the treatment period, unlike CG animals, a continuous positive improvement in these parameters was observed in the SG animals until the last week of the study. Plasma AST and ALT are accepted as important markers in the detection of liver damage (30). It has been shown that therapy with mineral water in experimental metabolic syndrome rats by giving fructose leads to a decrease in AST and ALT levels and a positive increase in TP and ALB levels (22).

There are studies reporting that hot spa therapy can be used effectively to reduce blood GLU levels (24,31,32). These positive effects of the hot spring have been reported to be related to regulating the distribution of absorbed nutrients followed by high blood sugar, possibly leading to impaired glucose tolerance (33). In the current study, the lowest GLU levels were detected in SG animalsand our results in parallel with the results of the above studies.

Hydrotherapy with water including CO_2 has been reported to cause a decrease in body temperature and an increase in cutaneous blood flow throughout the body or partial bath (34). With the absorption of mineral substances through the skin, nerve endings are stimulated and peripheral vasodilation is induced, resulting in an increase in cutaneous blood flow and improved microcirculation (5,15). As a result, peripheral vasodilation also helps to improve heart metabolism by causing increased parasympathetic and decreased sympathetic activity (34). In our current study, we observed severe degeneration, myocarditis, and local necrosis focuses in the heart tissue histopathology of animals that were created by giving isoproterenol, whereas the cases of myocarditis were almost completely recovered in SG rats treated with Süreyya I hot spring water. On the contrary, in CG animals, it was observed that this pathology still was continuing up to last day of the study. These findings were also compatible with studies reporting that the treatment with spa water is very effective in the treatment of myocarditis (35,36).

Conclusion

As a result; the clinical, hematological, blood biochemical parameters and histopathological examination findings obtained from thi study showed that treatment with Süreyya I hot spring water was very successful results in MI cases.

Declaration of conflict of interests/Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this article.

Informed consent

Informed consent was obtained from all patients included in this study.

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Table 1. Statistical comparison of body temperature, pulse and respiratory in the animals

Measurement Time/Parameters		T (°C)	P (frequence/min)	R (frequence/min)
		X±SD	X±SD	X±SD
	Groups			
BS (n=35)	-	37.30±0.30	314.50±68.40^{e}	105.20±30.10^{f}
AMIF (n=35)	-	37.40±0.40	344.20±80.50^{c}	155.20±78.10^{a}
AT 1st Day	CG (n=16)	37.30±0.10	360.30±75.20^{a}	154.20±68.30^{a}
	SG (n=16)	37.30±0.20	355.10±64.10^{ab}	153.50±65.20^{a}
AT 7th Day	CG (n=12)	37.20±0.10	350.20±50.40^{b}	144.30±43.20^{b}
	SG (n=12)	37.10±0.20	342.35±44.16^{c}	130.40±24.20^{d}
AT 14th Day	CG (n=8)	37.20±0.10	340.20±34.10^{c}	136.18±16.20^{c}
	SG (n=8)	37.10±0.10	324.10±25.40^{bc}	117.42±14.30^{e}
AT 21th Day	CG (n=4)	37.20±0.20	332.20±14.30^{d}	131.30±4.30^{d}
	SG (n=4)	37.10±0.10	315.20±13.30^{e}	107.20±4.20^{f}

a-f: Different letters in the same column are statistically significant (p <0.05). BS: Before study, AMIF: After myocardial infarctus formation, AT: After treatment, CG: Control group, SG: Study group

Table 2. Hematological findings of the animals

Measurement Time/Parameters		WBC (10^3/mm3)	RBC (10^6/mm3)	HB (g/dl)	HCT (%)	MCV (fl)	MCH (pg)	MCHC (g/dl)
	Groups	X±SD	X±SD	X±SD	X±SD	X±SD	X±SD	X±SD
BS (n=35)	-	13.57 ±5.18^{c}	8.55 ± 3.24^{ab}	13.42± 2.38^{a}	42.42 ± 3.34^{b}	49.23± 3.36^{c}	15.60±2.43^{a}	31.46± 3.45^{a}
AMIF (n=35)	-	15.42 ± 4.34^{a}	7.61 ± 3.25^{b}	13.78 ± 3.16^{b}	44.83 ± 4.08^{b}	58.31± 3.45^{a}	17.74± 3.43^{a}	30.69± 4.21^{b}
AT 1st Day	CG (n=16)	15.14 ± 5.46^{a}	7.75 ± 2.13^{b}	13.69 ± 3.34^{b}	45.14 ± 3.42^{ab}	57.55± 3.36^{b}	17.28± 3.27^{a}	30.21± 3.35^{b}
	SG (n=16)	15.28 ± 5.27^{a}	8.10 ± 1.56^{ab}	14.12 ± 2.37^{a}	44.67 ± 3.12^{b}	55.10± 2.54^{c}	17.48± 3.34^{a}	31.57± 3.31^{a}
AT 7th Day	CG (n=12)	14.99 ± 4.33^{a}	8.06 ± 1.34^{ab}	13.84 ± 2.41^{b}	45.41 ± 2.43^{a}	56.72± 2.52^{a}	17.13± 2.45^{a}	30.53± 2.43^{b}
	SG (n=12)	13.85 ± 3.47^{c}	8.15 ± 1.27^{ab}	14.22 ± 2.32^{a}	45.15 ± 2.61^{ab}	55.49± 2.41^{c}	17.39± 2.13^{a}	31.28± 1.67^{ab}
AT 14th Day	CG (n=8)	14.48 ± 3.44^{ab}	7.95 ± 1.22^{b}	14.07 ± 1.53^{a}	44.85± 1.63^{b}	54.61± 1.65^{c}	17.56± 2.13^{a}	31.25± 1.56^{a}
	SG (n=8)	13.09±2.18^{c}	8.33± 1.19^{a}	14.24 ± 1.45^{a}	45.22 ± 1.56^{ab}	54.92± 1.25^{c}	17.22± 1.47^{a}	31.42± 1.37^{a}
AT 21th Day	CG (n=4)	14.00 ± 1.57^{b}	8.07 ± 1.08^{ab}	13.90 ± 1.52^{b}	45.54± 1.48^{a}	56.52± 1.44^{ab}	17.18± 1.38^{a}	30.32± 1.26^{b}
	SG (n=4)	12.88 ± 1.36^{c}	8.45 ± 1.04^{a}	14.12 ± 1.38^{a}	45.85 ± 1.62^{a}	54.73± 1.39^{c}	16.71± 1.35^{b}	30.63± 1.31^{b}

Continuing Table 2

Measurement Time/Parameters		PLT (10^9/L)	LENF %	NOTR %	EOS %	MON %	BAS %
	Groups	X±SD	X±SD	X±SD	X±SD	X±SD	X±SD
BS (n=35)	-	29.34±8.11^{f}	70.38 ± 5.50^{a}	27.20 ± 4.30^{f}	2.48 ± 0.54	1.74 ± 0.56^{d}	ÖD
AMIF (n=35)	-	42.26±13.27^{a}	35.85 ± 6.30^{e}	58.50 ± 5.40^{a}	2.28 ± 1.50	4.89 ± 0.67^{a}	ÖD
AT 1st Day	CG (n=16)	42.13±14.23^{a}	34.12 ± 5.20^{e}	58.74 ± 5.10^{a}	2.40 ± 1.38	4.88 ± 0.46^{a}	ÖD
	SG (n=16)	41.09±12.03^{a}	35.12 ± 5.14^{e}	57.44 ± 5.32^{a}	2.25 ± 1.44	3.86 ± 0.32^{b}	ÖD
AT 7th Day	CG (n=12)	39.17±11.31^{b}	41.40 ±4.20^{d}	53.32 ± 3.40^{b}	2.24 ± 1.38	3.85 ± 0.24^{b}	ÖD
	SG (n=12)	36.27±9.06^{cd}	46.10 ± 4.20^{c}	50.20 ± 3.20^{d}	2.10 ± 1.32	2.87 ± 0.33^{c}	ÖD
AT 14th Day	CG (n=8)	37.47±7.03^{c}	42.20 ± 3.30^{d}	52.45 ± 3.10^{cd}	2.22 ± 1.36	3.84± 0.34^{b}	ÖD
	SG (n=8)	33.21±6.08^{e}	50.16 ± 3.30^{b}	47.42 ± 2.22^{e}	2.56 ± 1.30	1.81 ± 0.40	ÖD
AT 21th Day	CG (n=4)	35.31±5.07^{d}	42.28 ± 1.44^{d}	51.34 ± 1.48^{cd}	2.28 ± 1.30	2.85 ± 0.29^{c}	ÖD
	SG (n=4)	30.09±4.22^{f}	49.90 ± 1.35^{b}	45.35 ± 1.38^{e}	2.37 ± 1.26	1.65 ± 0.30^{d}	ÖD

a-f: Different letters in the same column are statistically significant (p <0.05). BS: Before study, AMIF: After myocardial infarctus formation, AT: After treatment, CG: Control group, SG: Study group

Table 3. Blood biochemical findings of the animals

Measurement Time/Parameters		ALT (IU/L)	AST (IU/L)	CK (IU/L)	CRP (mcg/ml)	TP (g/dl)	ALB (g/dl)	GLU (g/dl)
	Groups	**X±SD**	**X±SD**	**X±SD**	**X±SD**	**X±SD**	**X±SD**	**X±SD**
BS (n=35)	-	73.54±18.45^{e}	157.38±56.34^{e}	443.23±78.42^{g}	418.77±114.34^{e}	66.38±34.15^{a}	37.25±8.41^{a}	117.31±45.16^{a}
AMIF (n=35)	-	121.11±53.23^{a}	199.24±65.46^{a}	766.34±312.45^{a}	967.09±334.15^{a}	54.11±28.23^{e}	24.02±7.18^{e}	103.27±55.47^{c}
AT 1st Day	CG (n=16)	122.34±43.54^{a}	197.12±58.67^{a}	765.28±245.31^{a}	965.24±279.12^{a}	54.37±23.14^{e}	24.34±6.42^{e}	104.02±43.21^{c}
	SG (n=16)	121.32±44.14^{a}	198.34±56.14^{a}	763.11±237.08^{a}	966.11±283.08^{a}	54.43±22.15^{e}	24.35±6.41^{e}	105.56±39.14^{c}
AT 7th Day	CG (n=12)	108.20±31.14^{b}	183.21±36.34^{b}	745.14±145.22^{b}	951.03±167.16^{a}	55.28±11.42^{c}	24.86±4.09^{e}	106.15±23.12^{c}
	SG (n=12)	98.34±26.10^{c}	167.41±35.18^{c}	679.37±136.13^{d}	871.18±121.04^{b}	57.14±9.21^{de}	28.14±5.01^{c}	112.28±17.43^{ab}
AT 14th Day	CG (n=8)	102.21±17.45^{bc}	172.09±23.11^{bc}	728.06±113.24^{cd}	865.21±142.05^{b}	56.08±6.24^{e}	25.47±3.39^{e}	109.24±15.16^{b}
	SG (n=8)	82.16±7.23^{d}	161.45±21.16^{d}	551.12±98.07^{e}	643.09±88.11^{d}	60.11±5.12^{c}	32.25±2.14^{b}	116.18±12.43^{a}
AT 21th Day	CG (n=4)	100.05±6.16^{c}	170.14±14.12^{bc}	714.06±83.23^{d}	812.35±77.03^{c}	58.04±4.06^{d}	27.16±2.13^{c}	111.26±9.04^{d}
	SG (n=4)	79.14±5.08^{e}	157.08±9.32^{e}	471.16±756.13^{f}	436.05±63.16^{e}	64.03±3.42^{b}	36.18±1.59^{a}	118.27±7.21^{a}

a-g: Different letters in the same column are statistically significant ($p < 0.05$). BS: Before study, AMIF: After myocardial infarctus formation, AT: After treatment, CG: Control group, SG: Study group

Continuing Tablo 3 (Lipid profile)

Measurement Time/Parameters		TCHOL (mg/dL)	HDL (mg/dl)	LDL (mg/dl)	TG (mg/dl)
	Groups	**X±SD**	**X±SD**	**X±SD**	**X±SD**
BS (n=35)	-	92.64±11.14^{h}	46.08 ± 10.25^{a}	66.23± 21.32^{f}	95.44 ± 21.09^{e}
AMIF (n=35)	-	164.03±45.21^{a}	21.12 ± 16.43^{f}	139.35± 32.13^{a}	246.21 ± 45.18^{a}
AT 1st Day	CG (n=16)	162.44±38.23^{a}	22.01 ± 13.12^{f}	138.03± 29.11^{a}	252.13 ± 52.33^{a}
	SG (n=16)	142.26±34.14^{d}	22.02 ± 12.25^{f}	137.23± 27.21^{ab}	248.06 ± 48.31^{a}
AT 7th Day	CG (n=12)	157.26±32.34^{b}	23.14 ± 8.31^{f}	136.47± 22.09^{b}	249.15 ± 33.43^{a}
	SG (n=12)	128.37±21.11^{f}	31.34 ± 7.35^{d}	121.08± 16.12^{c}	201.28 ± 31.07^{c}
AT 14th Day	CG (n=8)	148.17±17.12^{c}	25.17 ± 7.09^{e}	135.34± 12.21^{b}	242.13 ± 28.23^{ab}
	SG (n=8)	119.43±12.05^{d}	38.06 ± 6.21^{c}	97.35± 9.16^{d}	178.49 ± 26.14^{c}
AT 21th Day	CG (n=4)	139.08±10.15^{e}	26.19 ± 6.34^{e}	131.44± 7.18^{c}	233.17 ± 18.13^{b}
	SG (n=4)	96.43±7.12^{g}	43.13 ± 5.18^{b}	76.28± 6.36^{e}	138.07 ± 16.06^{d}

a-h: Different letters in the same column are statistically significant ($p < 0.05$). BS: Before study, AMIF: After myocardial infarctus formation, AT: After treatment, CG: Control group, SG: Study group