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Full Length Research Paper

Effect of inspiratory muscle training with royal jelly supplement on iron metabolism in sedentary individuals

Zarife Pancar

Sport Science Faculty, Gaziantep University, Turkey.

ABSTRACT

The strength or weakness of respiratory muscles in comparison to other skeletal muscles due to their more specialized structures is considered as an indicator or cause of a disease. This study aimed to investigate the effects of royal jelly supplementation and royal jelly supplementation on iron metabolism in sedentary individuals. For this purpose, a total of 40 volunteers without any chronic disease were included in the study. Groups before the study; control group (n: 10), Royal jelly supplement group (n: 10), inspiratory muscle training group (n: 10) and supplement group + IMT (n: 10) were divided into four groups. Blood samples were taken from all groups for analysis of iron, iron binding and total iron binding levels. Maximal inspiratory pressure (MIP) and maximal expiratory pressure (MEP) measurement for the groups to do training was carried out with 40% of their MIP values. The training sessions were carried out at the same time every day for four weeks / five days. 1000 mg/day royal jelly supplied in glass vials was given to the supplement group. The SPSS version 22.0 program was used for statistical analyzes. As a result of the statistical analysis, significant was found in favor of the posttest compared to the control group in terms of both the pre-test and post-test values and the inter-group values in the group, royal jelly supplement, inspiratory muscle exercise group and RJ+IMT groups. It can be said that inspiratory muscle training made positive changes in iron metabolism and inspiratory muscle training plays an active role in the transport of oxygen by affecting iron metabolism in sedantary individuals.

Keywords: Sedentary, iron metabolism, respiratory exercise.

E-mail: z.pancar01@gmail.com, z_pancar@hotmail.com.

INTRODUCTİON

In the treatment of many diseases, the use of royal jelly is increasing day by day as a supplement to the medical treatment process (Hattori et al., 2007). Royal jelly is a dense milk product which young worker bees secrete from mandibular and hypopharyngeal glands and is used by to feed their larvae (Sabatini et al., 2009). Queen bees are fed with royal jelly starting from the larvae period and royal jelly directly affects the life of the bees, allowing them to live up to five years by giving eggs as heavy as their weights each day (Jamnik et al., 2007). It is recommended in order to minimize the damage caused by chemicals taken to the liver and kidneys and to protect these organs, especially in patients who use intensive antibiotics and receive radiotherapy and chemotherapy (Cornara et al., 2017). Due to these superior features, the use royal jelly as human food and its importance for human life and health are increasing more and more (Fratini et al., 2016).

The strength or weakness of respiratory muscles in comparison to other skeletal muscles due to their more specialized structures is considered as an indicator or cause of a disease. Similarly, strength and endurance of respiratory muscles can also be increased like all other skeletal muscles (Pardy et al., 1988). Inspiratory muscle training (IMT) is described as a remarkable exercise that exerts significant load on inspiratory muscles to strengthen the muscles of respiration (Silva et al., 2013). Respiratory muscle training has a rehabilitative effect as

well. It is one of the primary methods used in pulmonary rehabilitation (Weiner et al., 1999). Due to the strength-enhancing effect of respiratory muscle training on inspiratory muscle, it decreases the perception of dyspnea caused by decreased inspiratory muscle strength in COPD patients and provides an increase in exercise capacity (Hill et al., 2010). When studies conducted are examined, it can be seen that the positive effects of inspiratory muscle training have been determined on healthy individuals (McConnell and Romer, 2004), individuals with lung disease (Beckerman et al., 2005), healthy athletes (Arnall et al., 2014), obese individuals (Tenório et al., 2013), patients with hypertension (Ferreira et al., 2013), elderly smoking addicts (Jun et al., 2016) and healthy elderly individuals (Rodrigues et al., 2018).

Iron balance and regulation are very important as iron is essential in cellular metabolism and aerobic respiration. Iron balance disruption; the excess leads to cell death and toxicity through free radical formation and lipid peroxidation, as there is no way for the body to actively remove iron from the body. When it decreases, anemia and dysfunction are seen in many tissues. For this, iron homeostasis requires strict regulation (Gürsel et al., 2014).

Based on this information, the purpose of this study is to examine the effects of inspiratory muscle training and royal jelly supplementation on iron metabolism in sedentary individuals. This study is the first study thought to contribute to science in terms of the effects of inspiratory muscle exercises on iron metabolism, method and findings.

MATERIALS AND METHODS

Subjects

Forty healthy sedentary men without any chronic disease participated in the study voluntarily (Table 1). The groups were separated by block randomization technique. All subjects were informed about the study.

Groups before the study:

1st Control group (CG, n: 10): It is a sedentary group without any application.

2nd Supplement group (RJG, n: 10): It is the group that receives royal jelly (1000 mg / day) in addition to normal nutrition at the same time 5 days a week.

3rd Inspiratory muscle training group (IMT, n: 10): Two sets of 30 breaths were trained for four weeks / 5 days with the inspiratory device adjusted to 40% of the MIP baseline of each subject; and the inspiratory muscle training group that was given 1 minute rest between sets.

4th Supplement + Inspiratory muscle training group (RJG + IMT, n: 10): In addition to normal nutrition at the same time, 5 days a week, royal jelly (1000 mg/day) is given and inspiratory muscle training is given for 1 minute between the sets where two sets of 30 breaths are given for four weeks / 5 days.

Experimental design

This study is a randomized, experimental study with a control group. Subjects visited the lab three times for informational purposes. During their first visit, all subjects were informed about the study and their descriptive information was recorded. During their second visit, blood samples were taken from all subjects prior to the study. In their third visit, the standards of royal jelly supplement were determined and they were decided to visit the laboratory at the same time for four weeks. Groups given royal jelly supplement (1000 mg/day) were invited to the laboratory at the same time (between 09:00 and 11:00 h.) 5 days a week. Exercise groups, on the other hand, were inspected for 40 minutes of the MIP baseline value of each subject, and they were given two minutes of 30 breath training with a 1-minute rest between the sets.

Procedures

Royal jelly supplement

Royal jelly is seen as a beneficial natural food source for human metabolism and systems due to valuable substances contained in royal jelly content produced in the hypopharyngeal and mandibular glands of worker bees for the feeding of queen bees (Lipschitz et al., 1974). Royal jelly (Civan, Bee Farm, Bursa) was obtained in 1000 mg glass vials and was kept ready in the refrigerator. Groups supplemented with royal jelly received 1000 mg/day royal jelly in glass vials between 08.00 and 10.00 in the morning for four weeks.

MIP and MEP measurement

Electronic respiratory pressure meter was used to calculate MIP and MEP (Pocket Spiro MPM-100, Medical Electronic Construction R&D, Brussels, Belgium). Measurements were made using the nasal plug in a sitting position. For MIP; the person was given maximum expiration and asked to perform maximum inspiration against the closed respiratory tract and maintain it for 1-3 seconds. For MEP; the person was given maximum inspiration and the person was asked to make maximum expiration against the closed respiratory tract and maintain it for 1-3 seconds. The measurement was

Table 1. Descriptive information of subject (N = 40).

Parameter	CG Mean+SD	RJG Mean+SD	IMT Mean+SD	RJG+IMT Mean+SD
Age (years)	22.50 ± 3.54	21.87 ± 1.72	21.25 ± 1.66	20.12 ± 1.24
Height (cm)	178 ± 10.92	175.5 ± 5.85	175.75 ± 5.94	175.5 ± 2.39
Weight (kg)	77 ± 8.92	74.87 ± 7.58	77.25 ± 8.92	72.37 ± 7.50

repeated until there was 10 cmH_2O difference between the two best measurements and the best result was recorded in cmH_2O (Lomax and McConnell, 2009).

Inspiratory muscle training prosedure

A specific inspiratory training device (POWER®Breathe Classic, IMT Technologies Ltd., Birmingham; UK) was used for IMT. Training group subjects performed the IMT procedure at 40% of MIP (with +10% load increase each week and MIP test repeated on the first training day of every week). The IMT procedure included 30×2 dynamic inspiratory efforts (with 1 min interval) daily for 4 weeks (Kilding et al., 2010; Tong and Fu, 2006). A separate inspiratory muscle training device was used for each subject.

Blood test procedure

Venous blood samples were collected from the right arm of the participants into 5 ml purple capped tubes at the central laboratory of Gaziantep University Faculty of Medicine between the hours of 09:00 and 10:00 in the morning a day prior to the study and the day after the study. At the end of the study, in order to analyze iron, iron binding and total iron binding levels in the blood samples collected. Blood samples taken at the end of the study were analyzed automatically on the Beckman Coulter LH 780 instrument.

Statistical analyses

SPSS 22.0 (SPSS Inc., Chicago, IL, USA) program was used for statistical analysis. Values were represented as mean and standard deviation, and significance was set at 0.05. Kolmogorov-Smirnov test was performed to assess normality, and 2×4 mixed-factor analysis of variance and least significant difference tests were performed to analyze intra- and intergroup differences.

RESULTS

The results of the analysis are shown in Table 2. Accordingly, statistical significance was found in iron, iron binding and total iron binding capacities in favor of posttests in the supplement group, IMT group and RJG + IMT groups compared to the control group ($p < 0.05$). There was a statistically significant difference between the groups in the supplement group, IMT group and RJG + IMT groups compared to their controls ($p < 0.05$).

Table 2. Pretest and posttest values analysis of groups.

		CG Mean+SD	RJG Mean+SD	IMT Mean+SD	RJG+IMT Mean+SD
Iron	Pre-test	126.38 ± 29.62	84.29 ± 26.69	115.25 ± 41.30	99.14 ± 37.63
	Post-test	124.25 ± 24.64	112.57 ± 14.00^{A}	137.25 ± 45.22^{A}	127.43 ± 21.44^{A}
	Difference	-2.13 ± 38.17	28.29 ± 25.64^{B}	22.00 ± 55.26^{B}	28.29 ± 49.40^{B}
Iron binding	Pre-test	206.38 ± 44.85	230.00 ± 24.79	220.38 ± 74.53	246.00 ± 43.45
	Post-test	231.25 ± 42.90	217.57 ± 41.42^{A}	199.00 ± 67.58^{A}	228.43 ± 41.13^{A}
	Difference	24.88 ± 61042	-12.43 ± 44.21^{B}	-21.38 ± 67.65^{B}	-17.57 ± 67.77^{B}
T.I.B.	Pre-test	325.75 ± 22.97	349.86 ± 26.42	349.50 ± 42.62	363.00 ± 41.00
	Post-test	335.50 ± 37.42	311.86 ± 33.50^{A}	326.25 ± 30.67 ^{A}	335.14 ± 19.81^{A}
	Difference	9.75 ± 46.45	-38.00 ± 30.96^{B}	-23.25 ± 19.65^{B}	-27.86 ± 44.49^{B}

CG: Control group, **RJG:** Royal jelly supplemented group, **IMTG:** Inspiratory muscle training group, **IMT+RJG:** Inspiratory muscle training group+Royal jelly supplemented group, **A:** significant difference between pre- and post-tests, **B:** significant difference from CG, **C:** significant difference from S-CG.

DISCUSSION

This study investigated how royal jelly supplementation with inspiratory muscle training will affect iron metabolism in sedentary individuals. At the end of the study, it has been determined that these applications have positive effects in regulating iron metabolism in both groups receiving royal jelly supplements and respiratory muscle exercises.

Iron is an essential element for many living things and is of vital importance. It is involved in oxygen transport, energy production, DNA, RNA and protein synthesis with the ability to exchange electrons. It is also necessary for the structure and function of many enzymes, neurological functions and development. For normal neurological functions, the brain needs to store iron and be able to use it easily. Membrane ionic gradients, synaptic transitions, axonal transport require a lot of ATP (Babitt et al., 2007). ATP synthesis in the brain (cytochromes in the oxidative chain, acreitase and succinate dehydrogenase in crepe cycle), DNA synthesis (ribonucleoside reductase), synthesis of neurotransmitters and MAO (synthesis, metabolism, catabolism, synaptic range, dopamine, serotonin, serotonin, Iron is required in many important biochemical tasks, such as oligodendrite biology (lipid and cholesterol synthesis) (De Domenico et al., 2007). Iron is carried in the plasma by the transferrin, which is highly synthesized from the liver and has a glucoprotein structure. After the discovery of hepcidin, it was understood that the iron balance in the organism was with hepcidin, an antimicrobial protein synthesized in hepatocytes in the liver. Hepcidin is a hormone that regulates iron metabolism. Duedenal regulates iron balance by reducing iron in the organism by preventing the absorption of iron and the release of macrophage iron (Atanasiu et al., 2006). In our study, it was found that royal jelly supplementation and inspiratory muscle exercises changed positively in iron-iron binding and total iron-binding levels compared to the control groups.

Iron is an essential element necessary for all cells. Its most important task is to carry oxygen through hemoglobin. Iron catabolizes oxygenation, hydroxylation and many metabolic events (Lipschitz et al., 1974). Many studies have shown that respiratory muscle training has significant effects on respiratory muscles. It has been reported in several studies that the respiratory muscles will be stronger in a few days with respiratory muscle exercise, that the frequency of respiration decreases within three weeks, and that the performance increases as a result of the four-week respiratory muscle exercise (Volianitis et al., 2001; Romer et al., 2002; Lomax and McConnell, 2009). Iron is an essential element because it is necessary for erythropoietic function, oxidative metabolism and cellular immunity. The total amount of iron in the body for an adult man is 3500 mg (50 mg/kg). Most of the iron in the body is distributed within hemoglobin (65%; 2300 mg). Approximately 10% (350 mg) is in muscle fibers (myoglobin) and other tissues such as enzymes and cytochromes (Gürsel et al., 2014).

In our study, inspiratory muscle training and royal jelly supplement stimulated iron metabolism in compared to the control groups, resulting in a significant change in iron, iron binding and total iron binding capacity. The reason for this is that it is thought to be related to the increase of oxygen carrying capacity of the myoglobin in the muscle due to the work of the muscles.

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