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Effect of indoor climbing exercise on plasma oxidative stress, hematologic parameters and heart rate responses in sedentary individuals.

Gokhan Cesur[1], Emrah Atay[2], Serdal Ogut[3], Mumin Polat[3], Kurtulus Ongel[4]

[1]Department of Physiology, Adnan Menderes University, School of Medicine, Aydin, Turkey.
[2]Department of Sport Sciences, Suleyman Demirel University, Faculty of Health Sciences, Isparta, Turkey.
[3]Blood Bank, Suleyman Demirel University Hospital, Isparta, Turkey.
[4]Department of Family Medicine, Izmir Tepecik Research and Implementation Hospital, Izmir, Turkey.

Abstract

Indoor climbing is a worldwide sport with particular physiological and physical demands. With this study, it was aimed to investigate the effects of indoor climbing on oxidative stress, antioxidant levels and hematologic parameters. All results in the study were analyzed via using non-parametric Wilcoxon test with Statistical package for Social Sciences version 17 for Windows, with p<0.05 as the criterion for significance for all statistical comparisons. Fifteen voluntary male students whose average age is 22,35 ± 2,65 years old, participated in this study. These subjects were climbed 30 ± 1,25 times during eight weeks. Blood samples were collected at rest, 24h before, and 24h after climbing protocols to analyze total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) and hematologic parameters [Hemoglobin (Hb), hematocrit (Hct), platelet (Plt) and leukocyte (Wbc)]. Resting heart rates were measured at the same time. According to our findings, TOS (1,47 ± 0,06, 1,51 ± 0,02) (P:0.042) significantly increased, TAS (1,56 ± 0,04, 1,52 ± 0,03) (P:0.036) significantly decreased and OSI (0,94 ± 0,02, 0,99 ± 0,05) (P:0.014) significantly increased with climbing. There has been no statistically relation among the hematologic parameters. Data demonstrate that indoor climbing leads to increased plasma oxidative stress in sedentary individuals and can affect the athletes performance negatively.

Key words: Indoor climbing, oxidative stress, hematologic parameters, heart rate.

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Introduction

Indoor climbing is the most rapidly growing type of climbing and is now recognized as a modern competitive sport as well as a mode of fitness exercise. Climbing has been described as a vigorous activity that demands muscular power and strength, flexibility, and aerobic endurance [1]. It is reported that indoor climbing is adequate for increasing cardiorespiratory fitness and muscular endurance [2].

Although numerous studies regarding the beneficial effects of physical activities have been conducted in the past, there are also some others about the negative effects in more recent years [3]. Urso and Clarkson, in their study, established a link between physical exercise, elevated O_2 consumption, and free radical production [4]. Oxidative stress can be defined as an imbalance status between the radical oxygen species production and the antioxidant defence mechanism of the living organisms which in turn results in direct or indirect cellular damage [5].

It has been suggested that especially acute and intense exercises lead to oxidative stress, whereas regular endurance practices may decrease the exercise-induced oxidative stress and muscular damage and can enhance the antioxidant defense capacity [6]. There are various enzymatic and non-enzymatic antioxidant defense mechanisms in order to protect cell organelles and plasma membrane from the deleterious effects of free radicals [7]. The physiologic impact of exercise at various durations and intensities, including measurements of hematologic parameters, has been previously investigated [8,9].

In the literature, it has been reported that exercise gives rise to oxidative stress. Beside the negative effects of acute and irregular exercise, it is suggested that physical activities achieved in a regular fashion may lead to a dec-

rement in lipid peroxidation [10]. In more recent past, it has been emphasized that TOS and TAS measurements and evaluation can give more accurate results rather than a specific parameter look-up [6]. For this reason, we decided to evaluate TOS and TAS parameters in blood specimens collected from the participants.

The amount of scientific research that addresses the physiological demands of indoor climbing is relatively small. To date, only a few studies have compared the physiological characteristics of climbers with differing climbing ability [11]. It is evident that more research is needed to further clarify the physiological demands of indoor climbing. Thus, the main purposes of this study were to analyze the effect of indoor climbing exercise on plasma oxidative stress, antioxidant levels, hematologic parameters and heart rate responses before and after the climbing in sedentary individuals.

Materials and Methods

Study design

This is an observational analytic study.

Subjects

Fifteen voluntary male students whose average age is 22.35 ± 2.65 years old, participated in this study after being informed about the aims, experimental protocol, and procedures, and after providing written consent. Out of 37 students, 15 participated in the study on a voluntary basis. No sampling was made in the study.

Eligibility criteria: All university students, between 18-25 years old, who visited Suleyman Demirel University Closed Spore Hall during the given dates were admitted to study. Being a student in the university and visiting the hall were the inclusion criterias. Exclusion criterias were making any kind of sports, smoking cigarette and having a chronical disease.

Study duration: Study was performed between April-June 2011, in a three months period.
Setting: This study is performed at Suleyman Demirel University, Closed Spore Hall, Isparta, Turkey.

Climbing Wall

The climbing wall contained routes set upon portions of the wall that were strictly vertical or contained an overhang obstacle. In the beginning of the protocol, all of the subjects were familiar with each of the individual routes. The height of the wall was measured at 14m. These routes were considered as being achievable by beginner climbers. These subjects were climbed 30±1,25 times during eight weeks.

Physiological and Biochemical Measures

Heart rate (HR) was measured immediately prior to each climb and each the top of the climbing. A Polar RS400 HR monitor (Polar Electro Inc., Finland) was used to assess HR. Blood samples were collected at rest, 24h before and 24h after climbing protocols. All the venous blood samples were taken by conventional clinical procedures, using EDTA as an anticoagulant. TOS, TAS, OSI and hematologic parameters [Hemoglobin (Hb), hematocrit (Hct), platelet (Plt) and leukocyte (Wbc)] were analized in blood samples.

Measurement of the total oxidant and antioxidant status

Total antioxidant status (TAS) and total oxidant status (TOS) levels were measured spectrophotometrically using a commercial kit (Rel Assay Diagnostics, Gaziantep, Turkey) by the Erel methods [12,13]. These methods are automatic and colorimetric. The TAS measurement method is based on the bleaching of the characteristic color of a more stable 2,2-azino-bis (3-ethylbenzthiazoline-6-sulfonic acid) radical cation by antioxidants. The TOS method is based on the oxidation of ferrous ion to ferric ion in the presence of various oxidant species in an acidic medium and the measurement of the ferric ion by xylenol orange. The TAS and TOS results were expressed in mmol Trolox equivalent/L, μmol H_2O_2/L and mg/dL, respectively, and the precision error of this assay is lower than 3%.

Statistical Analysis: Statistical package for Social Sciences version 17 for Windows used for statistical analysis. The data were presented as means ± standard error of mean. All results in the study were analyzed via using non-parametric Wilcoxon test, with $p<0.05$ as the criterion for significance for all statistical comparisons.

Results

All subjects were previously familiarized with the indoor climbing and laboratory protocol carried out in the two data-collection sessions. The mean anthropometric characteristics of the climbers are shown in Table 1.

Table 1. *Anthropometric characteristics of the climbers.*

Age (yr)	22,35 ± 2,65
Height (cm)	180,64 ± 2,43
Weight (kg)	76,54 ± 8,24
BMI (Kg/m^2)	24,02 ± 2,16

The mean TOS, TAS and oxidative stress index (OSI=TOS/TAS) are shown in Table 2. TOS was significantly higher than before the climbing and after the climbing (p:0.042). But, TAS was significantly lower than before the climbing and after the climbing (p:0.036). OSI was also significantly higher than before the climbing and after the climbing (p:0.014).

The median of hematologic parameters are shown in Table 3. There was no relation between hematologic parameters and indoor climbing.

The mean resting heart rate and heart rate at the top of the climbing are presented in Table 4. Resting heart rate was significantly lower than before the climbing and after the climbing (p:0.032). Heart rate at the top of the climbing was significantly lower than first day the climbing and last day the climbing (p:0.024).

Table 2. *Effects of indoor climbing on plasma total oxidant status, total antioxidant status and oxidative stress index.*

Plasma	Before the climbing	After the climbing	P values*
Total Oxidant Status	1,47 ± 0,06	1,51 ± 0,02	**0,042**
Total Antioxidant Status	1,56 ± 0,04	1,52 ± 0,03	**0,036**
Oxidative Stress Index	0,94 ± 0,02	0,99 ± 0,05	**0,014**

*: non-parametric Wilcoxon test

Table 3. *Effects of Indoor Climbing on Blood Hemoglobin, Hematocrit, Platelet and Leukocyte Counts.*

Plasma	Before the climbing	After the climbing	P values*
Hemoglobin (gr/dl)	15,21 ± 0,67	15,07 ± 0,74	0,172
Hematocrit (%)	45,01 ± 1,42	44,80 ± 1,39	0,061
Platelet (mm^3)	225860 ± 43,46	225290 ± 37,90	0,734
Leukocyte (mm^3)	6600 ± 1,45	6770 ± 1,36	0,172

**non-parametric Wilcoxon test*

Table 4. *Effect of Indoor Climbing on Resting Heart Rate and Heart Rate at the Top of the Climbing.*

Heart Rate (b/min)	Rest			At the top of the Climbing		
	Before the climbing	After the climbing	P values*	First day	Last day	P values*
	79,14 ± 5,55	72,42 ± 7,72	**0,032**	184,42 ± 14,05	171,00 ± 17,02	**0,024**

**non-parametric Wilcoxon test*

Discussion

In this study, the relationship between indoor climbing and oxidative stress in sedentary individuals has analyzed during eight weeks. Data show that indoor climbing decreased plasma TAS and increased plasma OSI. In accordance with other studies, dealing with metabolic responses to indoor climbing; our data clearly confirm that a substantial contribution from the aerobic metabolism fulfills energetic needs for indoor climbing [14]. The significant increase observed 24h after the climbing exercise seems to demonstrate additional free radical production and an overwhelming of the antioxidant capacity. This increase in OSI observed after the climbing exercise might be explained by a marked decrease in plasma TAS.

We found that plasma TAS significantly decreased after the climbing exercise. As an integrated parameter that considers the cumulative status of some different antioxidants present in plasma, TAS provide an insight into the delicate in vivo balance between oxidants and antioxidants. Previously, it has been shown that both half-marathon running in trained male runners and treadmill running until exhaustion induced increases in TAS [15]. Like our findings, Anuhadra et al. have reported a decrease in non-enzymatical antioxidant activity after six weeks of aerobical exercise in rats [16]. In another study by Robertson et al, conducted on antrenary and sedantery individuals; it has been reported that erytrocyte superoxide dismutase (SOD) activity is lower in sedantery group compared to those of the antrenary group, which could be related to metabolical speed rate and free oxygen species production [17]. According to our findings, a functional decrease is likely to occur in non-enzymaticals antioxidants as a result of interaction with oxidants. Thus, we think that decrease in TAS levels can be attributed to the utilization of TAS during the neutralization process of the oxidants, which increase following the oxidant stress, by various reactions.

In this regard, it is likely that the increased oxidative stress observed during climbing exercise might have contributed, at least in part, to this free radical generating system. The imbalance between antioxidant capacity and

oxidant production induced by climbing exercise was also supported by some biomarkers of plasma oxidative damage representative of an ongoing pathophysiological process associated with oxidative stress. In a study conducted on 14 male platform climbers, Magalhaes et al have reported that MDA levels have significantly increased just one hour after the exercise [18]. Lovlin et al have indicated via performing bicycle ergometry test that lipid peroxidation increased in plasma and erytrocyte membranes during a moderate level exercise [19]. Exercise type, duration and intensity of participants' gender and qualifications, the periods before and after exercise, measurement differences in methods and tissue differences are the some possible causes for the changes in exercise-related TOS and TAS.

In our study, resting heart rates after climbing are significantly decreased compared to the rates before climbing. In addition, at the last day of the climbing exercise, on the top of the wall heart rates are significantly decreased compared to the first day on the top rates. Climbing imposes a physiological stress on the climber. However, climbers heart rates decrease with increasing of the climbing number and individual skills. Eight-week-long aerobic exercise climbing reduces heart rate speeds. These findings suggested that skill and technique play an important role in determining the energy cost of climbing, which in turn could influence the heart rate response. Janot et al study supports our finding by a significant decrease in HR from 179 to 159 beats /min [20]. The findings of this study may be beneficial to indoor climbing instructors. This information can aid in designing a climbing program to fit the individual needs of climbers based on their overall skill and fitness level.

Furthermore, in our study that has also investigate hematologic parameters before the climbing and after the climbing. There has been no statistically relation among the hematologic parameters. Similar to our results, in some studies show that the Hb, Hct, Plt, and Wbc levels aren't change immediately after exercise. However, in some studies reported significant differences in hematological parameters [8,9]. This differs from some previous reports and the reasons are unclear, but could relate to differences in exercise regimens, participant age, or timing of sample collection, which in this study was closer to the end of the exercise period than a previous study.

From the study, it is concluded that, indoor climbing exercise induces plasma oxidative stress and this stress may be exacerbated when the exercise is irregular. Moreover; antioxidant enzymes that reduce oxidative stress during exercise, are mostly associated with exercise training. There is only little certain evidence about antioxidant supplementation that they are beneficial for athletic performance. Besides; it seems certain that dietary antioxidants have positive effect, they can reduce the oxidative damage to muscles and other tissues caused by exercise. Nowadays; long-term effects of antioxidant supplementation are not fully understood and this subject must be investigated. According to our knowledge; it may be beneficial for individuals performing regular heavy exercise.

Limitations

Small sample size and non-probability sampling resulting in potential selection bias and hence poor external validity of the study were the main limitations of the study.

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Correspondence to:

Gokhan Cesur
Department of Physiology
Faculty of Medicine
Adnan Menderes University
Aydin-Turkey