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POSSIBLE ROLE OF EXERCISE IN AGING

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(Original Scientific Paper)

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Abstract

It is known that well balanced exercise slows down the aging process. The aim of the study was to determine the influence of exercise on endothelial stability related to the anti-aging process. Male healthy subjects (n=58) were submitted to the study: I – physically active subjects (n=21); II – previous physically active subjects (n=14) and III – sedentary subjects (n=23). Endothelial function was examined by following methods: nitric oxide - NO (Oxis, USA); free radicals - FR (Diacron, Italy); and superoxide dismutase in plasma and in red blood cells - SOD (Randox, G. Britain). Statistical significance for increased NO was found in I and II group compared to III group ($p<0.01$). FR was found decreased in I group ($p<0.05$) compared to other two groups. Plasma SOD was found decreased in III group ($p<0.05$). Exercise may increase NO production due to the muscles oxygen demand and may slow down the aging process.

Key words: *aging; exercise; endothelial function.*

Introduction

Endothelium has an important role in maintenance of cardiovascular health by adjusting vascular function with vasoactive substances production. These biologically active vasodilatator substances may decrease vascular resistance, inhibit platelet adhesion and aggregation, and decrease vascular smooth muscle cell proliferation. One of the most important vasoactive substances is nitric oxide (NO) that plays a crucial role in vascular homeostasis, including modulation of vasodilatation, regulation of local cell growth and platelet aggregation protection (1, 2, 3, 4). Dysfunction of endothelial cells may lead to atherosclerosis and other vascular diseases. Aging is defined as gradual accumulation of minor bodily injuries or degenerations, often associated with gradual decrease in functional capacity. It is related to gradually decline of endothelial function due to chemical or mechanical stimuli. Besides all, it may be based on several mechanisms such as oxidative stress (OS) and inflammation, which may lead to proliferative, pro-inflammatory, and pro-thrombotic state (5, 6). Thus, endothelium may become a host of hemodynamic stresses, oxidized lipids, and oxidative radicals. An appearance of OS, as a state of free radical (FR) overproduction and / or weak antioxidative capacity (such as enzyme: superoxide dismutase - SOD, glutathione peroxidase - Gpx, glutathione reductase, - GR, catalase - Cat and non-enzyme molecules) may contribute to endothelial impairment and may accelerate the aging process. Impaired endothelium may be linked to lack of vasoactive endothelial derived nitric oxide (NO), which has several physiological functions such as: vascular tone modulation by decreasing vascular resistance, inhibition of platelet adhesion and aggregation, and inhibition of vascular smooth muscle cell proliferation. Decreased NO production and increased OS may contribute to endothelium instability and provoke pathological conditions related to chronic diseases (7, 8). Recent studies have shown that well balanced regular exercise may slow down the aging process, via intact endothelial tissue and good tissue perfusion. It may restore age-related impairment of endothelial function, by alleviating inflammatory process and diminishing OS, *per se* (9, 10). The aim of the study was to determine the influence of regular exercise on endothelial stability related to anti-aging process.

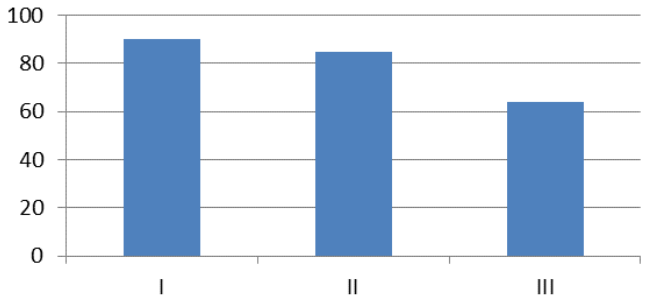
Material And Methods

The study was performed on 58 male healthy subjects (mean age of 53±7) divided in 3 groups: I – physically active subjects (n=21); II – previous physically active subjects (n=14) and III – sedentary subjects (n=23). The exclusive criteria for the study were: all chronic diseases, supplement therapy using, genetic disorders, and inclusive criteria were: at age above 50 years, body mass index below 24kg/m2, city inhabitants, modest intake of nitric food: nuts, fruit, meat and dairy products. The condition of the endothelial function was examined by the following parameters: a colorimetric method for NO (Oxis, USA), spectrophotometric method for FR (Diacron, Italy) and antioxidative enzyme superoxide dismutase in both, plasma and red blood cells - SOD (Randox, G. Britain). For statistical significance Student's t-test was performed for $p<0.05$.

Results

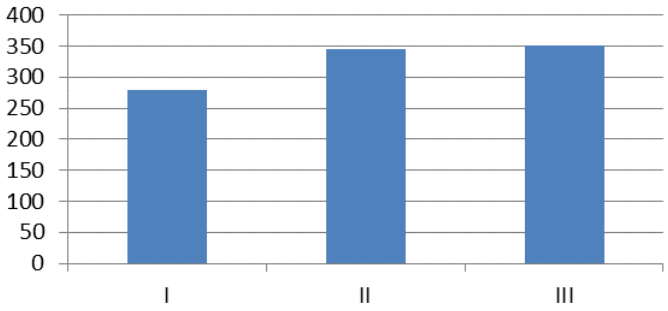
Endothelial function was examined by NO level. Statistical significance for increased NO was found in I and II group compared to III group ($p<0.01$) (Graph 1).

Graph 1. NO (µmol/ L) in subjects related to physical activity

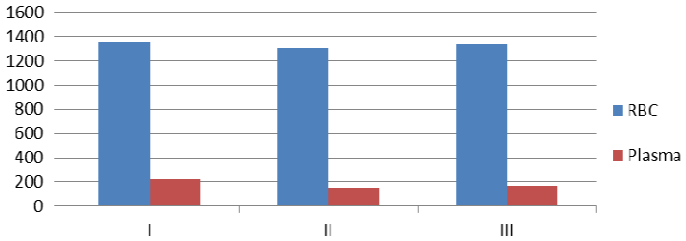


The highest value of NO was noticed in I subject group (90±36 µmol/L), compared to II group (85±28 µmol/L), and III group (64±27 µmol/L). FR were found decreased in I group, 280±31 UCarr ($p<0.05$) compared to both, II group, 345±22 and III group, 350±48 UCarr (Graph 2).

Graph 2. FR (UCarr) in subjects related to physical activity



Graph 3. SOD in RBC (U/grHb) and in plasma (U/L) in subjects related to physical activity



Plasma SOD showed highest value of 220±42 U/L in I group, compared to II group, 155±24 U/L and III group, 168±28 U/L ($p<0.05$), while no statistical difference was found for red blood cell SOD, I group - 1350±323 U/gr Hb, II group - 1300±280 U/gr Hb and III group - 1340±380 U/gr Hb (Graph 3).

Discussion

Our results show that exercise has athero-protective role due to increased NO and sustainable antioxidant defense. Thus, FR may be scavenged by the exercise due to activated antioxidant defense and increased plasma SOD. Furthermore, exercise in elderly people may increase NO production due to the muscles oxygen demand. As vasoactive substance, produced NO by the endothelium cells, causes dilatation of vessels and therefore regulates the blood pressure. Actually, vascular shear stress during exercise increases NO production from endothelial NO synthase. Then, NO either induces vasodilatation or may be metabolized to nitrite and nitrosothiols as storage that can be reduced into NO to prevent myocardial ischemia. Furthermore, nitrosothiols protects proteins from OS during reperfusion process. It also prevents pro-thrombotic condition which maintains intact endothelium and slows down the aging process. Well balanced exercise may prevent cardiovascular disease, such as coronary heart disease, heart failure, peripheral artery disease, and other chronic diseases (11).

There are studies that have shown that exercise prevents plaque development, improves coronary artery stenosis and has beneficial effect on other vascular lesions (12, 13). Regular exercise promotes endothelial-protection by preventing and/or decreasing both, OS and inflammation processes. Actually, OS is decreased by activation of laminar shear stress, down-regulation of endothelial angiotensin II type 1 receptor (AT1R) expression that decrease endothelial NADPH oxidase activity and superoxide anion production. This preserves the bioavailability of the vascular protective agent - NO, and promotes other vasoactive substances production (14). Therefore, balanced exercise may up-regulate antioxidant defense, increase repair mechanisms for oxidative damage, and improve resistance to OS. Regarding prevention of inflammation, skeletal muscle contraction, per se, releases anti-inflammatory cytokines such as IL-6 that inhibits tumor necrosis factor-α (TNF-α) showing athero-protective effect. Its anti-inflammatory effect may be also considered by reduced CRP plasma level. Another benefit of exercise is vascular remodeling which involves 2 forms of vessel growth: angiogenesis and arteriogenesis which may contribute for better tissue perfusion, especially in a case of artery occlusions (15). Due to many beneficial vasoactive agents released during physical activity, which are obviously involved in anti-oxidant and anti-inflammatory mechanisms of action, well regulated exercise may have beneficial effects on endothelial tissue and therefore have protective role on cardiovascular system integrity.

Our results confirm some recent studies that showed positive changes in physicaly active individuals, mostly based on endothelial stability and strong antioxidant defense. More studies are needed to support the beneficial mechanism of exercise, its protection from FR attack, supporting lipid, protein and gene stability, and its role as an anti-aging modulator.

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