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Original Research Article

The moderate physical exercise significantly increases von Willebrand's factor's activity and concentration in the blood

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ABSTRACT

Introduction: Physical exercise causes a range of physiological changes including the release of hemeostasis proteins to blood. Among them very important is von Willebrand factor (vWf) which is involved in both platelet adhesion and coagulation cascade.

Aim: The task of the study was to evaluate the effect of moderate physical exercise on plasma concentration and activity of vWf.

Material and methods: The impact of physical effort on vWf's concentration (vWf:Ag) and activity (vWf:CBA) underwent analysis in a group of 42 people (22 men and 20 women) aged 19–22, mean 20 years, SD 8 months). The effort consisted of 35 min of swimming in an indoor swimming pool.

Results and discussion: An increase of both parameters after exercise was observed in whole group, reaching mean values 58% and 69%, correspondingly, SD 60%. A big difference in reaction after effort was observed between the male and female group. In the male group the scale of vWf:Ag increase was higher than in female group, with increase of the mean value from 105%, SD 26% before the effort to 189%, SD 81% after the effort. In the female group the same mean parameter changed from 92%, SD 18% before to 120%, SD 23% after exercise. These differences were reflected in similar manner in the increase in vWf:CBA activity, which was 96%, SD 24% before and 134%, SD 46% after the exercise.

Conclusions: Even a moderate exercise significantly increases vWf levels and changes coagulation parameters.

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1. Introduction

Physical effort causes a range of physiological changes in an organism, among which the release of hemeostasis proteins to blood is an important but not thoroughly recognized one. One of the most important among these proteins is von Willebrand's factor (vWf). It is a glycoprotein with molecular mass up to 20×10^6 D possessing complex adhesive functions, and playing at least two functions (1) enables blood platelets adhesion on site of vessels' wall damage and (2) transports the coagulation factor VIII (FVIII) and protects it against proteolysis (II).[16,17] vWf is synthesized in megacarocytes and endothelium of blood vessels and released in a continuous (I) and controlled (II) manner. Measurements of plasma concentration (vWf antigen – vWf:Ag) and vWf activity, such as ristocetin cofactor (RCof) collagen binding assay for vWf (vWf:CBA), are necessary for the diagnosis of congenital or acquired bleeding disorders, especially of the von Willebrand's disease (vWD) and thrombotic thrombopenic purpura (TTP).[2,3,5] It is also indicated that the measurements of vWf are useful in the monitoring of the endothelium activation or damage. Along with pathological processes, physiological factors such as physical effort, stress or pregnancy significantly affect concentration and activity of plasma vWf. Also various genetic factors including ABO blood group polymorphism influence it and for this reason the results of population studies on the incidence of vWf abnormalities differ significantly.[4,15,17] The impact of physical effort being probably the most common interfering factor, in spite of being listed in publications, is not researched thoroughly. Publications concerning this issue are based on, for the most part, small group of subjects, and, moreover, it is difficult to determine the reason for changes – whether they were caused by physical effort itself or perhaps tissue constriction or local circulation stasis.[7,8,9,10,20,24,27]

2. Aim

The aim of our research was to evaluate the process of releasing vWf in experimental method, which excludes or minimalizes phenomena connected with tissue constriction as a factor stimulating the release of vWf. In order to carry out these assumptions, we chose swimming as an optimal model of exercise, evaluating changes of plasma concentration (vWf:Ag) and activity (vWf:CBA) of vWf.

3. Material and methods

The research aimed at evaluating the process of vWf release, as a result of physical effort, excluding the impingement of injuries or tissues pressure and tourniquet. The study was conducted on the group of 42 volunteers, 22 females and 20 males aged 19–22 (20.0 ± 0.70 years) trained in swimming. The levels of swimming abilities across the group were similar and determined intermediate. Blood used to determinate vWf:Ag concentration and vWf:CBA activity was drawn approximately 10 min before a 35-min period of freestyle swimming and immediately afterwards. Blood was drawn in accordance with standard procedure from cubital vein, using sodium citrate (in 1:9 ratio) as anticoagulant, centrifuged for obtaining platelet poor plasma, which was then frozen and stored until the examination date in a refrigerator at the temperature -20°C. Concentration of vWf (vWf:Ag) was determined using enzyme-linked immunosorbent assay (ELISA) with the application of commercial DAKO (Denmark) reagents according to the company recommended procedure. The measurements of vWfs activity were performed using the test of vWf:CBA according to Falvarolo procedure taking into account own modifications of the flattening process (using Sigma, USA, human collagen type III and DAKO conjugate).[3,12] The research was carried out upon the approval of the committee of bioethics, as well as a written approval of a subject. The project was approved by regional bioethics committee and followed by confirmed agreement of all participants according to required procedure.

4. Results

The examinations conducted have shown that the physical effort of 35-min swimming caused a considerable increase of the plasma vWf concentration and activity. Both parameters evaluated in the group increased considerably – vWf:Ag by 58%, vWf:CBA by 69%. Along with the differences in ontogenetic reaction to the effort, a statistically considerable difference between the male and female group was observed (Tables 1 and 2, Figs. 1–4). In the male group vWf activity (AWF:Ag) was increasing by 81% on average, and its vWf:CBA activity by 99% ($p < .001$, Tables 1 and 2). In the female group the scale of increase was lower and reached 28% for vWf:Ag and 36% for vWf:CBA activity ($p < .001$, Tables 1 and 2). The subjects differed considerably in the scale of reaction to effort, differing both in the scale of increase of vWf:Ag plasma concentration and vWf:CBA plasma activity. Some individuals showed no reaction after effort while some others reacted with extremely high release of vWf to blood reaching almost 300%. Individual measurements of their changes are illustrated in Figs. 1–4. The change in the coefficient of correlation between vWf concentration and activity before and after the effort was also observed. The coefficient of Pearson's correlation between vWf:Ag and vWf:CBA has changed after exercise. Before the exercise its value was 0.69 ($p < .001$; Fig. 5), and after the exercise it increased to 0.92 ($p < .001$; Fig. 6).

5. Discussion

In all examined volunteers, the exercise consisting of a 35-min swim caused the increase in vWf:Ag concentration and vWf:CBA activity of vWf in blood. Observed interontogenetic differences are considerable (Figs. 1–4), yet they do not affect statistic inference. Significant statistic differences were observed in the scale of vWf concentration and activity increase between male and female groups. Physical effort has been deemed the reason for vWf increase in blood; yet, as we have determined in the introduction, literature data confirming this fact are not numerous, while for vWf:CBA activity there are none at all. The results of early experiments were not clear, and in some subjects the exercise caused the release of vWf,[20] and in it others did not.[18] At present, this fact leaves no doubt. The highest two- and threefold