TACSM Abstract

Effects of Pulsatile Exercise-Induced Shear Stress on eNOS, SOD, VCAM-1, and ICAM-1 mRNA Expression of Human Carotid Artery Endothelial Cells

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ABSTRACT

Exercise-induced endothelial shear stress (ESS) has been proposed as a molecular mechanism that regulates the expression of genes involved in the protection against atherosclerosis. However, research on this topic has not considered the pulsatile nature of blood flow for *in vivo* ESS estimations. **PURPOSE**: to analyze the effect of pulsatile exercise-induced ESS on endothelial nitric oxide synthase (eNOS), superoxide dismutase (SOD), vascular cell adhesion molecule 1 (VCAM-1), and intercellular adhesion molecule 1 (ICAM-1) mRNA expression of human carotid artery endothelial cells. **METHODS**: A reverse translational approach was employed for this study. First, an *in vivo* assessment, a total of 24 apparently healthy young subjects (14 females and 10 males) were recruited to perform two exercise tests on a cycle ergometer. The first test was a maximal incremental test which established the workloads for the next session, according to lactate levels. The second one, performed at least 48 hours after the first exercise test, was a steady-state test at lactate levels of <2 mmol/L for 5 minutes. Left common carotid artery diameters and velocities were recorded through Doppler ultrasound. Microhematocrit measurement was used to determine blood density (ρ) and viscosity (μ). ESS was calculated by Womersley's approximation, ESS = μ * 2K * Velocity/Diameter, where K is a function of Womersley's parameter (α). Thereafter, in an *in vitro* experiment, commercially available human carotid artery endothelial cells were cultured on 6 slides until 95-100% confluence and were randomly assigned to no ESS exposure or were exposed to anterograde pulsatile flow (OsciFlow®) in a flow chamber (Streamer®) for 35 minutes, simulating exercise-induced ESS from the previous assessments. Finally, eNOS, SOD, VCAM-1, and ICAM-1 mRNA expression were compared between both groups, using GAPDH as the housekeeping gene. **RESULTS**: Exercise-induced ESS for lactate <2 mmol was on average 56.32 (14.82) dynes/cm². A significant increment on eNOS mRNA expression ($P<0.05$) and a significant reduction on SOD mRNA expression ($P<0.05$) were observed on those cells exposed to exercise-induced ESS compared to the group without ESS exposure. No significant differences were detected on mRNA expression of VCAM-1 and ICAM-1 between both groups. **CONCLUSION**: Pulsatile ESS generated during 35 minutes of low-intensity cycling might favor the upregulation of eNOS and the downregulation of SOD which in turn could provide a molecular explanation of the beneficial effects of exercise on atherosclerosis.