Transcranial Direct Current Stimulation and Sport Performance: Brain Derived Neurotrophic Factor and Neurotrophins as Potential Biomarkers of Abuse

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INTRODUCTION

Transcranial Direct Current Stimulation (tDCS) is a non-invasive and painless brain stimulation technique that involves neuronal excitability and neuronal plasticity through the application of direct current in a specific area of the brain [1]. This peculiar form of Brain stimulation can also represent a potential force of "electroemotional doping" (or "brain doping"), since it is an innovative concept in the field of performance-enhancing methods in sport. In present, however, the list of substances banned by World Anti-Doping Agency (WADA) does not include this kind of poison. In principle, tDCS can boost sports performance by using technologies that induce stimulation of some brain areas and resulting changes in the brain activity. These stimuli include enhancement in muscle strength, reduction of the sense of fatigue, reduction of recovery time, and concentration [2]. tDCS is delivered by an electrical stimulator through a constant-current unit and isolation unit connected with two electrodes placed on the scalp, one electrode is glued over the motor cortex and the second over the parietal ridge or in a non-epileptic area, and recruit current (usually 2 mA) flows from a negative electrode (cathode) to a positive electrode (anode). Reverse direction of current flow determines two types of tDCS: anodal stimulation, that is excitatory, and cathodal stimulation, that is inhibitory. Anodal stimulation seems to be capable to increase sports performance in comparison to both the cathodal stimulation and no stimulation, because excitability of motor cortex decreases fatigue-related muscle pain, and increases motor and perceptual learning, motivation and power. The effects of tDCS on physical performance were recently assessed by using a " Halo light" or "d" device, that is a commercial tDCS system. It consists of a breast similar to a conventional headphones made by Halo Neuroscience (San Francisco, CA, United States). It use has improved repeated sprint cycling power output, skiers' jumping force, and their coordination [2] (4). In view of a potential abuse of these devices, it would be necessary to identify diagnostic biomarkers representative of the mechanism underlying the stimulation. The most promising biomarkers candidate are Brain Derived Neurotrophic Factor (BDNF), glutamate and dopamine, whose serum levels are increased following tDCS [5]. The aim of this project is to analyse the variability in serum of BDNF, in presence proBDNF and other neurotrophins, in view of their selection as possible biomarkers to detect the transcranial direct current stimulation (tDCS) used to enhance physical performance.

MATERIALS AND METHODS

Transcranial Direct Current Stimulation was performed in accordance with the Declaration of Helsinki. The only inclusion criteria was a self-report that the subject had never undergone tDCS stimulation. The assessment was conducted on a total of 74 people (30 men, 44 women), in age range 18-60 (mean age 30.5±10 years). The participants were chosen from a pool of 1000 volunteers and were divided into two groups (AGE: 1-20 years and AGE: 50-60 years). All of the subjects received an explanation about the purpose of the study and the general procedure of the analysis. The classification of the BDNF polymorphisms, as well as genetic or biochemical analysis, were conducted in the same laboratory. The BDNF polymorphisms were determined by the sequence of the corresponding exon 2 of the BDNF gene [6]. The presence of the polymorphism was determined using real-time PCR. The statistical analysis was performed using the IBM SPSS software.