Stimulated Saliva Aminotransaminase Alteration After Experiencing Acute Hypoxia Training

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Abstract

Objective: Acute hypobaric hypoxia is generally recognized to be the most serious single physiological hazard during flight at altitude. Simulation of acute hypoxia in an altitude chamber is used for the training of military aircrew. Acute hypobaric hypoxia affects critical organ systems in different manners. The purpose of this study was to investigate stimulated saliva glutamic pyruvic transaminase (GPT) and glutamic oxaloacetic transaminase (GOT) alteration after the hypobaric hypoxia process.

Methods: A cross-sectional study was performed in 44 normal healthy military aircrew conducted at the hypobaric chamber of physiology at the University of Medical Sciences, Tehran, Iran. The GPT and GOT activities were assayed in stimulated whole saliva before and after the experience of hypobaric hypoxia by the International Federation of Clinical Chemistry method. Statistical analysis of the Student *t*-test was performed.

Results: The mean stimulated saliva GPT activity was significantly higher after the experience of the hypobaric hypoxia process (2.83 $\pm$ 0.34 vs. 0.42 $\pm$ 0.029 U/L, respectively; P = .001). Saliva GOT activity was also increased after this process (3.32 $\pm$ 0.43 vs. 1.22 $\pm$ 0.18 U/L, respectively; P = .001).

Conclusion: Results suggest that subsequent to the experience of the hypobaric hypoxia process, there is a rise in the salivary activities of aminotransferases.

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Hypobaric hypoxia is accepted as the most serious potential danger during flight. High-altitude exposure has been considered a major cardiorespiratory, endocrine, metabolic, nutritional, thermal, and psychological strain for the human body. It has been stated that the fall in total barometric pressure and the consequent reduction in partial pressure of oxygen poses the greatest single threat to anyone who flies. The 3 main causes of hypoxia in aviation are ascent to altitude breathing air, failure of oxygen equipment, and rapid cabin decompression. Even today, hypobaric hypoxia remains a potential threat to aviators who routinely fly above 3,048 m. Because there is always a risk of equipment failure at altitude, early recognition of hypoxic symptoms is mandatory. The earliest feature of hypobaric hypoxia is often a subtle personality change perhaps coupled with euphoria, lack of judgment, loss of short-term memory, and mental incoordination.[1] To counter the hypobaric hypoxia threat, military aviators receive periodic training using a reduced oxygen breathing device (hypobaric chamber). A hypobaric chamber (altitude chamber) is a chamber used during aerospace or high terrestrial altitude research or training to simulate the effects of high altitude on the human body, especially hypoxia (low oxygen) and hypobaria (low ambient air pressure). The aircrew returns every 3 years to receive refresher hypoxia recognition training. Exposure to hypobaric hypoxia induces a process of the following immediate physiologic responses to maintain an adequate tissue oxygen supply: respiratory, cardiovascular, cerebrovascular, and visual responses.[2]

The physiological responses to hypoxia are now well recognized, but little work has been reported on the changes in the profiles of tissue enzymes under conditions of acute, severe, and nonacclimatized short-term high-altitude hypobaric hypoxia. Some effects of hypobaric hypoxia in the human body include increased expression of heme oxygenase 1, heat shock proteins, and growth factors such as vascular endothelial factor and erythropoietin.[3] Biomarkers of oxidative stress, including lipid hydroperoxides, total phosphocreatine kinase activity, and myoglobin, have been identified.[4]

Hypobaric hypoxia is a stressful situation and can result in catecholamine release. In some organs, catecholamine hormones cause vasoconstriction (eg, the gastrointestinal tract and kidney), and in other vital organs (eg, the heart, brain, and muscles), they result in vasodilatation for blood supply. After this vasoconstriction and reduced oxygen supply, these organs impose more hypoxic stress and injury. Therefore, hypobaric hypoxia that imposes in an altitude chamber and hypoxia induced with reduced perfusion after vasoconstriction in some organs increase probable tissue damage and allow intracellular biomarkers to be released into the blood.

Glutamic pyruvic transaminase (GPT) or alanine aminotransferase is found in large amounts in the liver, and small amounts of this enzyme are also found in the heart, muscle, and kidney. Glutamic oxaloacetic transaminase (GOT) or aspartate aminotransferase is found in many body tissues including the heart, liver, muscle, gingival epithelial cells, kidney, brain, and lung.

Saliva is a major determinant of the oral environment and serves as an easily available diagnostic tool of systemic conditions. It has been determined that a number of markers are present in saliva; therefore, its use as a diagnostic fluid could have significant diagnostic and logistic advantages when compared with serum. As a diagnostic medium, saliva has several advantages; its collection is safe, noninvasive, inexpensive, and simple, and it may be collected repeatedly without discomfort to the patient.[5,6]

Because the aviation staff should experience hypoxia in the hypobaric altitude chamber, this could affect different tissues including the liver cells. Therefore, the experience of the acute hypobaric hypoxia process in a simulated altitude chamber may have some side effects on aircrew. In this article, we assess the activity level of aminotransferases (GOT and GPT) in a group of aviation staff before and after the experience of the hypobaric hypoxia process (ie, breathing pure O_2 with atmospheric pressure, ascending to a 30,000-ft altitude, breathing hypobaric air until the appearance of hypoxic signs, and descending to ground level) in an altitude chamber. Because the aminotransferases are approximately sensitive and specific measurement for liver cells, the results could indicate the presence of minor liver injuries in these conditions that were neglected before.

Materials and Methods

Subjects

The Ethics Committee of the Aja University of Medical Sciences, Tehran, Iran, approved the study protocol. Informed consent was obtained from all participants. A total of 44 military male aircrews were asked to participate in a cross-sectional study conducted at the hypobaric chamber of physiology at the Aja University of Medical Sciences and was designed in accordance to the recommendations of the Declaration of Helsinki. The participants were between the ages of 22 and 43 years and were not taking any medication at the time of the study. Smokers, obese patients (body mass index >30), patients with systemic diseases, and patients with a bad oral health condition were excluded. However, none of the participants were excluded in our study for these reasons. They had no previous history of medical problems and no history of liver disease or prior jaundice. During all the experimental protocol, food and fluid ingestion were not allowed.

Hypobaric Hypoxia Experience Process

The altitude chamber, aviators were explained before flight. Then, a mask was fitted, and an oxygen regulator and internal communication system were connected. Ascendance to 5,000-6,000 ft was performed to check the Eustachian tube function and its ability to drain the sinuous and middle ear. Ascendance and descent velocity were 3,000 ft/min. The reascendance velocity to 8,000 ft was 3,000 ft/min. Acute pressure reduction happens at 8,000-18,000 ft in 8-10 seconds. Mask removal was performed at a 25,000-ft altitude in order to experience hypoxia. It was terminated if hypoxic symptoms developed. The duration of hypoxic exposure was 3-5 minutes in this study.

Saliva Collection

Stimulated whole saliva was collected under resting conditions in a quiet room between 9:00 am and 12:00 pm before and after exposure hypoxia. Stimulated salivary samples were obtained by expectoration after chewing a standard piece (1 g) of galipot wax. Collection was started after 1 minute of chewing. Saliva was collected into a dry, deionized, and sterilized plastic tube. For saliva sampling, all participants received detailed information about the collection protocol. They were asked to avoid eating and drinking 2 hours before starting hypoxic experience. All samples were located in refrigerator after centrifugation at 2,500*g* for 15 minutes.

Analysis of Saliva

Whole saliva was assessed colorimetrically by a photometer and using affiliated kits (Pars Azmun, Karaj, Iran) for the total activities of GOT and GPT by the International Federation of Clinical Chemistry.

Statistical Analysis

For statistical analysis, the data are presented as a mean ± standard error of the mean. The 2-tailed Student paired *t*-test was used to compare salivary aminotransferase before and after the experience of hypobaric hypoxia. $P < .05$ was considered statistically significant.

Results

The participants had a mean age of 31.5 years (range, 22-43), a mean height of 178.4 cm (range, 165-192), and a mean weight of 80.8 (range 63-105). The mean duration of hypoxic exposure was 4 minutes (range, 3-5).

The stimulated salivary concentration of GPT proved to be significantly higher in military aircrews after the experience of the hypobaric hypoxia process ($P = .001$, Fig. 1). The mean stimulated whole saliva concentration of GOT was also higher in military aircrews after the experience of the hypobaric hypoxia process ($P = .001$, Fig. 1).

Discussion

For experiencing of hypobaric hypoxia sign, aircrew should be placed inside the simulated chamber all 3 years at once. In