

Effects of positive acceleration on the metabolism of endogenous carbon monoxide and serum lipid in atherosclerotic rabbits

Huilan Luo, Yongsheng Chen, Junhua Wang

General Hospital of Air Forces, Beijing, PRC

Address for correspondence: Dr. Huilan Luo, Department of Cardiovascular Diseases, General Hospital of Air Forces, 30 Fucheng Road, Beijing 100036, PRC. E-mail: ls0001@sina.com

ABSTRACT

Background: Atherosclerosis (AS) is caused mainly due to the increase in the serum lipid, thrombosis, and injuries of the endothelial cells. During aviation, the incremental load of positive acceleration that leads to dramatic stress reactions and hemodynamic changes may predispose pilots to functional disorders and even pathological changes of organs. However, much less is known on the correlation between aviation and AS pathogenesis. **Methods and Results:** A total of 32 rabbits were randomly divided into 4 groups with 8 rabbits in each group. The control group was given a high cholesterol diet but no acceleration exposure, whereas the other 3 experimental groups were treated with a high cholesterol diet and acceleration exposure for 4, 8, and 12 weeks, respectively. In each group, samples of celiac vein blood and the aorta were collected after the last exposure for the measurement of endogenous CO and HO-1 activities, as well as the levels of total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). As compared with the control group, the endocardial CO content and the HO-1 activity in aortic endothelial cells were significantly elevated at the 4th, 8th, and 12th weekend, respectively ($P < 0.05$ or < 0.01). And these measures tended upward as the exposure time was prolonged. Levels of TC and LDL-C in the experimental groups were significantly higher than those in the control group, presenting an upward tendency. Levels of TG were found significantly increased in the 8-week-exposure group, but significantly declined in the 12-week-exposure group (still higher than those in the control group). Levels of the HDL-C were increased in the 4-week-exposure group, declined in the 8-week-exposure group, and once more increased in the 12-week-exposure group, without significant differences with the control group. **Conclusions:** Positive acceleration exposure may lead to a significant increase of endogenous CO content and HO-1 activity and a metabolic disorder of serum lipid in high-cholesterol diet-fed rabbits, which implicates that the acceleration exposure might accelerate the progression of AS.

Key words: Endogenous carbon monoxide, Heme oxygenase-1, lipoprotein, positive acceleration exposure, total cholesterol

DOI: 10.4103/0975-3583.64439

INTRODUCTION

Atherosclerosis (AS), the most important pathologic process leading to cardio- and cerebrovascular diseases, is suggested to be mediated by the increase in the serum lipid, thrombosis, and injuries of the endothelial cells.^[1,2] During aviation, a kind of special occupation, pilots may experience an incremental load of acceleration that leads to dramatic stress reactions and hemodynamic changes. The positive acceleration exposure, especially repeated exposure, may cause accumulative adverse stress reactions in the body.^[3]

The situation may predispose pilots to functional disorders and even organic changes in various corporeal systems. For example, a pilot experienced a bout of idiopathic ventricular tachycardia originated from the outflow tract of the right ventricle during an aviation^[4]; another pilot developed an onset of paroxysmal atrial fibrillation during a flight preparation^[5]; and there were reports on myocardial infarction episodes during centrifuge simulation or aviation^[6,7] As described by Zheng *et al.*,^[8] among 39 pilots receiving coronary arteriography because of symptoms, such as choking or chest pain, 8 were confirmatively

diagnosed as having coronary atherosclerotic heart disease. In accordance with related regulations, once a pilot is found developing coronary heart disease, regardless of the extent of the disease, the pilot must withdraw for permanent grounding. This sort of nonbattle withdrawal would significantly undercut the combat capability of the Air Forces. In this article, the authors treated AS model rabbits with positive acceleration exposures (+Gz) by using an animal centrifugal machine, and then observed the variation of endogenous carbon monoxide (CO) content, heme oxygenase-1 (HO-1) activity in the aortic endothelial cells, and serum lipid level. The study provided experimental evidences to delineate the correlation between aviation and AS pathogenesis.

MATERIALS AND METHODS

Establishment of AS model

A total of 32 healthy male adult purebred New Zealand rabbits (provided by the Animal Center of the Academy of Military Medical Sciences, Beijing, China), weighed between 1.0 and 1.5 kg, were fed with high fat diet with cholesterol powder 1.5 g daily for 3 months.^[9] During the experiment, they were fed with high fat diet continuedly.

Grouping of experimental animals and sample collection

The rabbits were randomly divided into 4 groups with 8 rabbits in each group. The control group was given a high cholesterol diet but no acceleration exposure, whereas the other 3 experimental groups were treated with a high cholesterol diet and acceleration exposure for 4, 8, and 12 weeks, respectively. In each experimental group, routine disinfection, anesthesia, and laparotomy were performed for sample collection after the last acceleration exposure at the 4th, 8th, and 12th weekend, respectively. Approximately 100 mL of blood sample was drawn from the abdominal vein. The aorta was removed and frozen, and then was prepared with paraffin section, fixed with paraformaldehyde, desiccated at room temperature, and stored at -70°C for use.

Experimental devices and reagents

The animal centrifuge was provided by the Air Forces Aeromedicine Institute (Beijing, China), with an arm length of 2.0 m, acceleration range 0.5–15 G, and G onset rate 0.1–6 G/s. The measurement reagent kits were provided by the Beijing Yili Fine Chemicals Ltd (Beijing, China).

Acceleration exposure of animals

The animals were exposed under +4 Gz for 3 consecutive rotations with each rotation lasting for 20 s. The G onset rate was set at 1 G/s and the interval between 2 rotations was 5 min. The centrifuge was performed 3 times a week. A weekly increment of +0.5 Gz was given until the acceleration was increased up to +6 Gz at the 5th week with each rotation lasting for 40 s. Samples of aorta and abdominal venous blood were collected after the last acceleration exposure at the 4th, 8th, and 12th weekend, respectively.

Determination of HO-1 activity

The aorta samples from the control group and the 3 experimental groups were prepared into a homogenate, and then mixed with buffer solution for deep freeze at -70°C and repeated freeze–thaw for 3 cycles. After centrifugation, the supernatant was mixed with the test reagent in lightproof container at 37°C for 1 h. The unit of measurement for HO-1 activity was pmol/(mg/h). Quantitative assay of protein was performed by using the Coomassie brilliant blue staining.

Measurement of CO content

Vascular rings of 3–5 mm in length were obtained from the aorta sample and were mixed with 2 mL of phosphate buffer (pH 7.4; 0.01 mol/L) for homogenate preparation; 0.2 mL of homogenate was taken in a cuvette and 0.2 mL of redistilled water was taken in another for control. In each cuvette, 2 mL of hemoglobin solution was added and mixed well, and 0.1 mL of sodium dithionite solution was added, mixed, and maintained still for 10 min. As compared with blank control, the optical density at 541 nm (OD, 541) and 555 nm (OD, 555) were measured by using the model 721A spectrophotometer.

Measurement of serum lipid

By using the Hitachi model 7600 automatic analyzer (produced in Ibaraki, Japan), total cholesterol (TC) and triglyceride (TG) were measured with double-reagent enzymatic method, and high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were measured using the double-reagent clearance method.

Statistical analysis

Statistical analysis was carried out using SPSS software (ver. 10.0, produced by IBM Company, Chicago, USA). Experimental data were treated by analysis of variance for determining differences among the groups. All data were

Download English Version:

<https://daneshyari.com/en/article/2965650>

Download Persian Version:

<https://daneshyari.com/article/2965650>

[Daneshyari.com](https://daneshyari.com)