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EEEFECT OF HYPERBARIC CONDITIONS ON THE TIMING OF THE VISUOMUSCULAR REFLEX IN DIVERS

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ABSTRACT

This paper presents the results of a study of the effects of hyperbaric conditions with positive pressures of 1 to 6 atm on visuomotor reflex timing. The experimental group consisted of divers from the Navy.
A prolongation of the reaction time was found, particularly evident in the overpressure ranges 0 - 1 atm and 5 - 6 atm.
Keywords: hyperbaric conditions, nitrogen, visuomotor reflex, diving.

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INTRODUCTION

The study of the timing of sensory-muscular reflexes has its established usefulness in psycho-physical testing of candidates for various professions [1,2,3,4]. It is also of great value in assessing the impact of various harmful factors on humans, such as noise, high-altitude flights, excessive physical and mental effort, etc. This issue is addressed in the works by numerous authors [5,6,7,8,9,10]. Bojko [2], on the other hand, in his monograph entitled "Human reaction time", discusses this subject extensively and the world literature in this field.

The aim of this study was to investigate the behaviour of visual-muscle reflex time in divers placed in an air hyperbaric chamber.

MATERIAL AND METHODOLOGY

Our sample consists of 50 trained divers aged between 20 and 24 years, holders of a diving licence, taking part in regular training classes and performing underwater work. The study was conducted with rested divers during the morning hours. After the divers had been placed in the high-pressure chamber, their eye-muscle reflex time was determined sequentially at normal atmospheric pressure at 1 atm, 2 atm, 3 atm, 4 atm, 5 atm, and 6 atm. The residence time in the chamber (including the decompression period) was approximately 1 hour. The tests were performed while the chamber pressure was being raised and lowered. The measurements went on for 25 minutes.

Visual-muscle reflex timing was measured as follows; the diver in the chamber observed the light signal. The diver responded to the signal given by the examiner by pressing a button held in his right hand. The moments of signalling and the diver pressing the button were recorded. The time difference between the two is the visual-muscular reflex time. During the study period, the ambient temperature varied between 18-20°, in the chamber up to 24°C; the CO_2 level in the chamber did not exceed an acceptable concentration. Air temperature was measured using an "Ellab" thermocouple thermometer. The CO_2 level was determined continuously during the experiments in the chamber using a PGA-DU-1958/62 apparatus.

RESULTS OF STUDIES

The results of the study are summarised in Table I as mean visual-muscular reflex times obtained in 50 divers in the chamber at varying air pressures from normal to 6 atm.

Tab. 1

Pressure in atm.	normal	1	2	3	4	5	6
Reflex time in m/sec	226	278	257	265	250	257	331

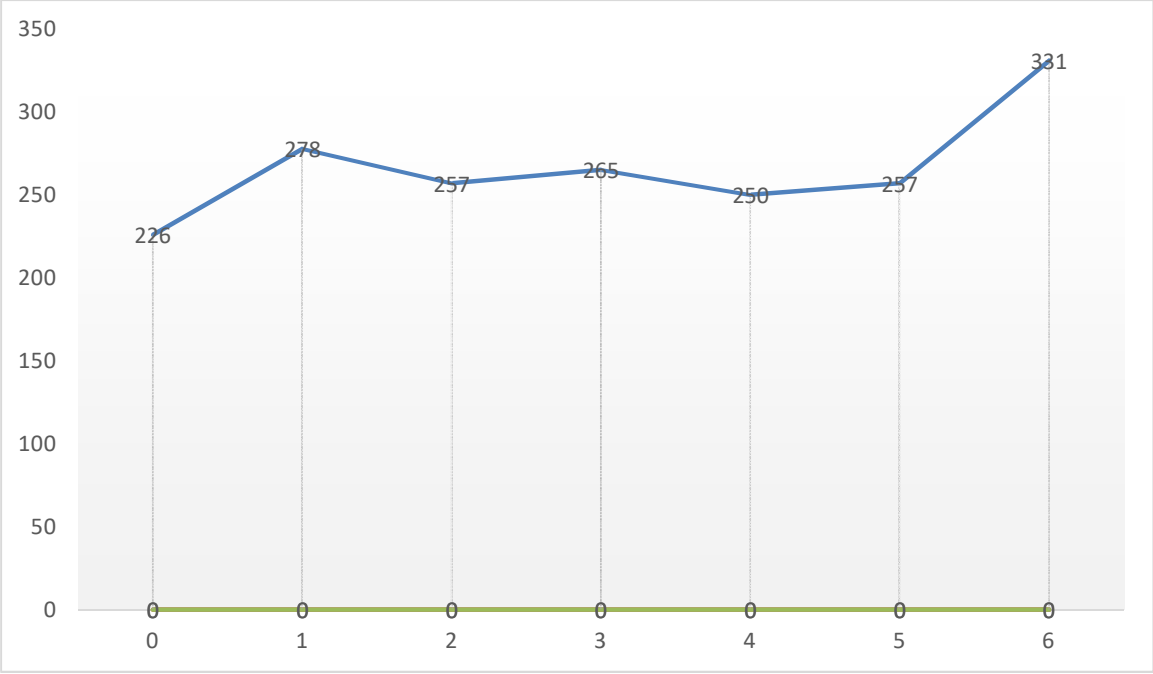

Fig. 1 Mean visual-muscle reflex times in 50 divers as a function of increasing chamber air pressure.

A graphic representation of the mean visual-muscular reflex times in 50 divers as a function of changes in chamber pressure is shown in Fig.1.

DISCUSSION

A human being placed in a compressed air chamber is exposed to all the constituents of the chamber's atmosphere. The harmful effects of exhaled CO_2 are eliminated by adequate ventilation of the chamber. In our experiment, the constant control of CO_2 in the chamber through adequate ventilation avoided the harmful effects of CO_2 on the body and on the timing of the visuomotor reflex. The effect of CO_2 on the timing of this reflex has been discussed, among others, by Sergeev [11]. Ventilation also ensured adequate oxygen levels, as lack of oxygen could affect the experiment [12]. The studies were conducted at a maximum air pressure = 6 atm, the oxygen partial pressure was a maximum of 1.26 atm, which within the generally accepted oxygen toxic limit of 1.8 atm. and the short duration of the stay in the chamber could not affect the test results. The air temperature in the chamber was about 20°C. Only during pressurisation did it reach 24°C for a short period of time. Ventilation immediately compensated for these heat fluctuations. The exclusion of these additional factors, which could affect the timing of the visual-muscular reflex, supports the idea that the changes during this time are due to the action of the pressurised air on the diver.

The results of our study show an overall significant and statistically significant (coefficient of significance d = 5.0) prolongation of the visual-muscular reflex time of divers placed in a chamber at pressures ranging from normal to 6 atm. There were individual variations, but the prolongation of the reflex time occurred in all divers. When considering the changes in visual-muscular reflex time at individual pressures, two main spikes could be observed (Table 1 and Fig. 1).The first statistically significant (d=2.7) extension of this time occurred between normal pressure and 1 atm. The load on the body from the changed pressure is proportionally highest here and the pressure increases by 100%, which could explain the occurrence of this phenomenon. With a further increase in pressure, these proportions change and the body adapts more easily to the new conditions. According to our results, the time of the visual-muscular reflex varies with an increase in chamber pressure from 1 to 5 atm within small limits. The differences in these times are not statistically significant. A second statistically significant (d=4.0) prolongation of the visual-muscular reflex time was observed at 6 atm. This seems to depend on the narcotic effect of dissolved nitrogen in the body. Behnke, Davies, Dolatkowski, Huszcza et al. report that at pressures around 6 atm. and higher, nitrogen has a narcotic effect, causing symptoms of the syndrome popularly known as 'deep-sea ecstasy' [13,14,15,16].

According to Dolatkowski [15], the initial symptoms of nitrogen's narcotic effect include excitement, increased mood with a concomitant decrease in mental and physical abilities, difficulty in focusing attention and intrusive thoughts. These symptoms resemble alcohol intoxication or symptoms of anoxemia. Davies [14], Haldane [17] and others report that air of normal composition at high pressure has toxic effects that can be prevented by replacing nitrogen with helium or hydrogen. There is no sufficient diving basis to explain the toxic effects of nitrogen. Guraud [18] speculates that it depends on; an increase in the solubility of nitrogen in the lipids of the nervous tissue, an increase in the density of nitrogen under elevated pressure and a decrease in the release of CO_2 from the body. This would therefore involve a synergistic effect of the two gases. Behnke [13] also believes that there is an individually different response to the narcotic effect of nitrogen. The results of our study seem to confirm the observations on the narcotic effect of nitrogen in hyperbaric conditions. This effect could be explained by a sharp increase in the time of the visual-muscular reflex when moving from a pressure of 5 to 6 atm. It is also reasonable to assume that the initial symptoms of nitrogen narcosis can be captured at 6 atm pressure by measurements of the visual-muscular reflex time, taking into account the individually varying resistance to its effects. A significant prolongation of this time with high pressure would indicate low tolerance to the narcotic effect of nitrogen. The method of determining the visual-muscular reflex time may allow the elimination of particularly sensitive individuals. Its use would provide divers breathing compressed air on depth dives with greater safety and improve underwater work.

CONCLUSIONS

1. In divers placed in a high-pressure chamber in a compressed air atmosphere, the time of the visual-muscular reflex is prolonged.
2. Significant differences in the time of visual-muscular reflex can be seen when the pressure changes from normal to 1 atm. and from 5 to 6 atm. This is presumably related in the first case to the proportional effect of nitrogen on the human body.
3. The study of the timing of the visual-muscular reflex in hyperbaric conditions may allow the elimination of individuals sensitive to compressed air.

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