EFFECTS OF INTERVAL HYPOXIC PRETRAINING ON RESPONSE OF BLOOD OXYGEN TRANSPORT CAPABILITY TO ACUTE HYPOBARIC HYPOXIA IN HEALTHY SUBJECTS

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The aim of the study was to investigate effects of interval hypoxic pretraining (IHPT) on oxygen transport in healthy subjects. 45 healthy young male volunteers (students of Medical University) aged 18-24 years were divided randomly into three groups. Volunteers of the first group (n=15, IHT group) received interval hypoxic training (IHT), volunteers of the second group (n=15, Placebo group) inhaled atmospheric air through the mask in the mode similar to that used for IHT. The third group (n=15, Control group) was involved only in acute hypobaric chamber experiment. Before IHPT blood oxygen transport parameters of all subjects were measured at see level and in acute hypoxia at the simulated altitude of 3000 m in a hypobaric chamber for 2 hours. After IHPT, the parameters were measured again. After IHPT, significant changes in response to acute hypoxia were revealed, indicating increase in PaO_2, $Pa\text{-}vO_2$ and SaO_2. The obtained data suggest improved oxygen transport capability and favorable effect of IHPT on oxygen support to the tissue.

Key words: interval hypoxic pretraining, acute hypoxia, oxygen transport.

Oxygen transport capability determines the ability of arterial blood to supply oxygen to tissues. Normal oxygen transport capability provides for the normal function of the tissues under normal physiological circumstances. When organism is elevated to high altitude, the diminished oxygen pressure in the inspired air, as a result of lower atmospheric pressure at the altitude, changes blood oxygen transport capacity. We have shown that the adaptation to the high altitude hypoxic environment improves oxygen transport capability [1]. The interval hypoxic training has been demonstrated to provide beneficial results in responses of the organism to different stress factors [2-3].

The aim of the study was to investigate the effect of interval hypoxic pretraining (IHPT) on selected indices of oxygen transport in healthy subjects.

Methods

Subjects:

45 healthy young male volunteers (students of Medical University) aged 18-24 years were involved in the study. The subjects were divided randomly into three groups. Volunteers of the first group (n=15, IHT group) received interval hypoxic training (IHT) course according to the method [4] described by E.N. Tkatchouk et al. with gradual increase of the total hypoxic exposure time in one session from 15 to 62 min, and decrease of oxygen content in hypoxic gas mixture from 11 to 9.5%. 20 IHT sessions were performed (one session a day, every day). HypoxyComplex $HypO_2$ (Switzerland)was used for IHT. Volunteers in the second group (n=15, Placebo group) inhaled atmospheric air through the mask in the mode similar to that used for IHT. The third groups (n=15, Control group) were involved only in tht acute hypobaric chamber experiment.

Experiment:

Before IHPT, blood oxygen transport parameters of all subjects were measured at see level and acute hypoxia at the simulated altitude 3000 m in a hypobaric chamber for 2 hours. After IHPT, the parameters were taken again. The subjects were elevated to high altitude at a rate of 5 m/s. Chamber atmospheric pressure and oxygen partial pressure were 70.0 and 14.5Kpa, respectively.

Collection and Measurement of blood samples:

The objects were placed in the supine position. Radial artery and intermediate vein were sterilized with iodine solution in alcohol. Blood samples were collected using sterile single-use plastic syringe for 2 ml. Four blood samples for every subject were collected: at sea level and 3000 m before and after IHPT. Blood samples were analyzed using ABL3 automatic acid-base analyzer (Radiometer, Denmark). The following parameters were measured in blood of volunteers; oxygen tension in arterial and venous blood, oxygen gradient in arterial and venous blood, oxygen saturation.

Statistics:

All data are presented as Mean (S.E.M., parameters measured at sea level and after 2 hours exposure to acute hypoxia were assessed using group T-test, aiming to evaluate the difference between before and after IHPT. Differences were considered statistically significant when p value was less then 0.05.

Table. Effects of IHT on the response of blood oxygen transport capability to acute hypobaric hypoxia (M±S.E.M.).

		PaO_2, mm Hg		PvO_2, mm Hg		SaO_2, mm Hg		$Pa\text{-}vO_2$, mm Hg	
	Group	Sea level	3 000 m	Sea level	3 000 m	Sea level	3 000 m	Sea level	3 000 m
Before IHT course	IHT	111.9±1.2	53.6±1.4	36.4±2.0	31.3±1.7	98.0±0.2	87.1±0.9	72.8±2.7	22.0±2.5
	Placebo	111.9±1.9	53.4±1.9	34.8±3.9	29.5±1.6	98.1±0.2	86.4±1.3	77.2±4.0	23.9±3.3
	Control	109.8±2.4	57.2±1.6	33.9±1.8	32.0±1.9	98.0±0.2	88.0±0.9	75.9±2.5	23.2±1.9
After IHT course	IHT	116.7±1.5*	62.4±1.6**	37.4±1.9	31.0±1.5	98.4±0.1	91.3±0.6**	73.9±2.5	31.2±1.9**
	Placebo	114.3±1.8	53.5±1.3	37.7±3.4	32.1±1.8	98.2±0.1	86.3±1.0	76.5±4.0	21.4±2.0
	Control	114.2±1.8	58.9±1.9	36.1±2.3	36.3±2.0	97.9±0.2	87.6±1.3	72.6±3.3	23.1±2.2

* - $p<0.05$; $p<0.01$ - significant difference before - after IHT course.

Results

1. Oxygen tension of arterial and venous blood.

Table shows that oxygen tension (PaO_2) of arterial blood of IHT group at sea level and at 3000 m after IHPT is higher than before IHPT. PaO_2 of other two group (placebo and control) were not change after IHPT.

Oxygen tensions of venous blood (PvO_2) were not change in any group both at the sea level and at 3000 m as a result of IHPT (Table).

2. Oxygen gradient in arterial and venous blood.

Oxygen gradient in arterial and venous blood was evaluated by oxygen tension difference between arterial and venous blood ($Pa\text{-}vO_2$). It can be seen from Table that $Pa\text{-}vO_2$ was changed significantly after IHPT at 3000 m in IHT group. IHT group showed a higher $Pa\text{-}vO_2$ at 3000 m after IHPT than before IHPT at 3000 m ($p<0.01$).

3. Oxygen saturation (SaO_2).

Oxygen saturation reflects both oxygen utilization and current oxygen transport capacity. Table shows that SaO_2 in IHT group at 3000 m was higher after IHPT than before IHPT ($p<0.01$).

Discussion

Oxygen is the most important component for sustaining human life. Oxygen transport is one of the factors determining how efficiently arterial blood supplies oxygen to the tissue. The arterial blood oxygen transport properties are in turn determined by the oxygen tension. The transport capability determines the ability of the arterial blood to supply oxygen to the tissue. It is expressed by PO_2 and SaO_2 values [5]. So, we measured PaO_2, $Pa\text{-}vO_2$ and SaO_2 in the experiment with IHPT.

The experimental results showed that PaO_2, SaO_2 and $Pa\text{-}vO_2$ of IHT group increased after IHPT. These changes could be considered to reflect the improved oxygen transport capability and, thus, a favorable effect of IHPT on oxygen support of tissues. The reasons for and mechanism of this phenomenon are poorly understood, and further research of this matter is required.

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