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CLINICAL RESEARCH

Modern Possibilities of Hyperbaric Oxygen Therapy in Pregnant Women with Anemia

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Abstract

Over the past 20 years, the number of anemia cases has increased more than 6-fold. Unfortunately, the treatment of pregnant women with anemia using an iron supplement gives unsatisfactory results. However, the data from the present study can change situation for the better. This conclusion was derived from a comparative analysis of the treatment of 65 pregnant women suffering from anemia, divided into two groups: the study and control groups. Patients of the study group received, along with standard therapy, courses of hyperbaric oxygenation (HBO). Evaluation of treatment efficiency was based on data from laboratory methods, Doppler, and cardiotocography before and after treatment, as well as a morphological study of the placenta. The received results show that the use of HBO in the complex treatment of pregnant women with anemia may take place in clinical practice both for treatment of anemia during pregnancy, and for the prevention of complications of pregnancy and childbirth.

Keywords: *pregnant women; anemia; hyperbaric oxygenation (HBO).*

Introduction

Anemia and pregnancy is one of the most urgent problems of modern obstetrics. According to WHO, it is estimated that 41.8% of pregnant women worldwide are anemic. At least half of this anemia burden is assumed to be due to iron deficiency [1]. Though the role of iron deficiency in producing anemia among pregnant women is beyond any doubt, unfortunately, treatment of such pregnant women with an iron supplement gives comparatively poor results. Despite the large amount of research devoted to the study of this disease, up to now the downward trends in its frequency were not observed [2]. Anemia is highly resistant to any modern methods of treatment, and the number of complications it causes cannot be compared with any extragenital disease [3]. Anemia during pregnancy as an oxygen deficit condition is like a clinical model for the study of various aspects of hypoxia in the mother and the fetus [4]. Long before pregnancy, anemia causes angiopathy of the uterine vessels, which leads to the realization of placental insufficiency during pregnancy in these women [5]. HBO may compensate a haemoglobin deficiency by increasing levels of plasma-dissolved oxygen. Hyperbaric therapy was first documented in 1662, when Henshaw built the first hyperbaric chamber, or 'domicilium' [6]. Since this time, reports of beneficial effects from increased pressure have increased, and by 1877, chambers were used widely for many conditions, though there was little scientific rationale or evidence.

Research conducted by the US military after the Second World War brought greater knowledge about survivable pressures. As a result, the use of HBO increased, and throughout the late 1950s and early 1960s, HBO was used to potentiate radiotherapy effects, prolong circulatory arrest during surgery [7], and to treat anaerobic infections [8] and carbon monoxide poisoning [9]. Concerns about lack of scientific progress and regulation led the UHMS to form a Committee on Hyperbaric Oxygen Therapy in the late 1970s, which is now the international authority on HBO.

The effects of HBO are based on the gas laws, and the physiological and biochemical effects of hyperoxia. HBO has complex effects on immunity, oxygen transport and haemodynamics. The positive therapeutic effects come from a reduction in hypoxia and edema [10]. HBO is a relatively safe treatment, but does carry some risks, due to the increased pressure and hyperoxia. Clinical and experimental evidence does not support claims that HBO during pregnancy can cause a range of fetal complications [11,12], including spina bifida

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and limb defects [13].The only absolute contraindication to HBO is an untreated tension pneumothorax, and this must be excluded before treatment.

The purpose of the study was to determine the effectiveness of HBO courses in the treatment of anemia and prevention of perinatal complications in pregnant women.

Material and Methods

We analyzed 65 pregnant women with anemia who were treated in the maternity department of Bauman Clinical Hospital #29 in Moscow. Informed consent was obtained from each patient. The study was approved by the Peoples' Friendship University of Russia and the Bauman Clinical Hospital #29 Ethics Committees.

The study group comprised 40 patients with moderate anemia (Hb: 86.5±1.5g/L, erythrocytes: $2.8 \cdot 10^{12}$/L), who, in addition to the standard treatment of anemia, received HBO sessions. The control group consisted of 25 patients with anemia who received only standard treatment. Exclusion criteria were the absolute (an untreated pneumothorax) and relative contraindications to the use of HBO (a history of epilepsy, viral infectios, pacemaker, claustrophobia, etc.). Pregnant women of the study group received, besides the complex therapy, the HBO sessions (excess air pressure 1.3-1.5 atm. in a pressure chamber). We used a single-system OKA-MT (Russia), equipped with air-conditioning 54–58A and designed to conduct sessions in a high-pressure oxygen environment. The mode is one excess atmosphere [14]. The course includes 5–7 daily sessions lasting 40 minutes each. The first course was carried out in 6–8 weeks, the second in 16–18 weeks, and the third in 22–24 weeks of pregnancy. The choice of given periods of pregnancy was determined by important stages in the formation of the utero-placental area. Since the earliest period of the therapeutic effect on blood flow in the utero-placental area to correct the violations may be considered 7–8 weeks and 16–18 weeks of gestation until the end of the first and second waves of cytotrophoblast invasion.

Evaluation of treatment efficacy was based on data from clinical and laboratory findings before treatment and after its completion. The following hardware methods of research were performed: ultrasonography (USG) of the woman's abdomen and fetal cardiotocography (CTG) of the fetus. Dynamic fetomonitoring was performed daily for all patients during treatment in the obstetrics hospital. These data were entered into a specially designed card. After birth, the morphological study of the placenta was conducted in accordance with the order #28 of MoH RF from 29.04.94 ("On the order of postmortem studies").

Assessment of the newborn was done on the Apgar scale in the first and fifth minutes of life. Based on this assessment, we analyzed the early neonatal period. To assess the degree of CNS of a child, a clinical assessment of neurological status was made.

Results were statistically processed using the software package Statistica 6.0 for Windows. The mean (M) and standard deviation (SD) were deduced. Analysis of the distribution of values obtained was performed using the Kolmogorov-Smirnov test. For data with normal distribution, inter-group comparisons were performed using Student's t-test. A value of $P<0.05$ was considered statistically significant.

Results

The mean age of patients in the study group was 26.5±4.7 years. The average body weight of patients was 65.6±9.2 kg, the average height 163.9±7.1 cm in both groups. It was found that primiparas dominated in both groups: 68.1%, vs 31.9% for secundiparas.

In the analysis of extragenital diseases, in addition to anemia, cardiovascular disease was diagnosed in 3 (7.5%) patients of the study group and 6 (24.0%) patients of the control group. Respiratory diseases (chronic laryngotracheitis, chronic bronchitis) were registered in 7 (17.5%) patients of the study group and 5 (20.0%) patients of the control group. The diseases of the gastrointestinal tract (chronic gastritis, chronic cholecystitis, chronic pancreatitis) were diagnosed in 11 (27.5%) patients of the study group, and in 7 (28%) patients of the control group. Urinary system diseases (chronic cystitis, chronic pyelonephritis) were observed in 17 (42.5%) patients of the study group and in 19 (76%) patients of the control group.

Gynecological diseases were reported in 37 (56.9%) patients in the two groups with the dominance of inflammatory disorders of the appendages in 17 (42.5%) patients of the study group and in 20 (80%) patients of the control group.

Examination of the course of pregnancy found that the threat of termination of pregnancy was significantly more frequent in the control group; it was observed in 15 (60%) patients of the control group and in 9 (22.5%) of women who received HBO. In the control group, the course of pregnancy was complicated by preeclampsia in 14 (56%) cases, while in patients receiving HBO preeclampsia was diagnosed in 4 (10%) cases. Birth occurred vaginally in 83.9% of the study group patients and 68.0% of the control group patients. Study of childbirth complications revealed the majority cases were premature rupture of membranes. This complication occurred more often in the control group than in the study group: 8 (32%) vs 4 (10%) Emergency cesarean section was performed in 11 patients: 5 (12.5%) in the study group and 6 (24%) in the control group. In the control group, 9 (36%) patients had placental insufficiency; primary weakness of labor was found in 2 (8%) patients, and narrow pelvis in 1 (4%) patient. In the study group, 7 (17.5%) patients had decompensation placental insufficiency as a basis for emergency delivery by cesarean section. Cesarean section was done in a planned manner (at high myopia, retinopathy, uterine muscle scar after prior cesarean section, breech presentation of a large fetus) in 7 (17.5%) patients of the study group and in 10 (40%) patients of the control group.

The treatment of the studied patients in both groups caused an increase in hemoglobin levels. This increase was more pronounced in the cases of HBO. Before the HBO courses, the hemoglobin level in the study group was 86.5±1.5g/L; after the HBO courses the level was 110.5±1.5g/l ($P<0.05$). In the control group patients, during pregnancy,

hemoglobin level was not statistically changed. Against the background of treatment with HBO, there was a significant increase in the number of red blood cells by 0.12×10^{12}/l, in the platelet count by 9.5×10^{9}/l, and in the protein levels by 3.09g/l in relation to the indicators in the standard treatment group. Dynamics of ferrokinetic indicators in pregnant women are shown in Table 1.

Table 1.

Dynamics of ferrokinetic indicators during treatment

Variable	Group 1 n=40		Group 2 n=25		P^*_{1-2}
	before	after*	before	after*	
Serum Fe,mmol/l	3.9±0.6	13.2±1.9	4.1±0.8	9.0±1.7	<0.001
Ferritin,μg/l	10.3±2.6	19.5±5.1	11.2±1.4	18.3±6.8	>0.05
Transferrin,g/l	4.3±0.19	4.24±0.57	3.9±0.1	3.88±0.2	<0.01

After HBO courses in the studied patients, there was significant improvement in Doppler data. Indicators of utero- and fetoplacental blood flow increased by 32%, whereas in the control group patients it increased only by 17%. At the application of HBO, cardiotocography parameters were improving, showing an increase in amplitude and frequency of oscillation and the disappearance of decelerations.

The Apgar score was 7.2±1.3 points in the first minute of life and 7.8±1.2 points in the fifth minute of life in newborns of control group mothers. Thus, in the first-minute and fifth-minute the average Apgar score in the study group was significantly higher compared to the control group (7.6±0.5 points and 8.4±0.7 points), $P<0.05$.

Conclusion

The essence of HBO is connected with the fast rise of oxygen's strain in tissues due to an increase in the quantity of soluble blood oxygen, increasing the speed of diffusion between the blood and the hypoxic area of tissue. The source of oxygen supply is soluble oxygen in plasma. Under an increase in its pressure, the speed of oxygen transfer from blood to intertissue liquid is raised and from there to the cells, where biological oxidation takes place with the help of enzymes [10,14]. Comparative analyses of clinic-laboratory results proved that HBO contributes to improving the functions of breathing and blood circulation; improves adaptive possibilities of the cardio-vessel system, microcirculation and indicators of fetoplacental system; and improves the process of erythropoiesis, the course of pregnancy, and the period after birth. The use of HBO in pregnant women with anemia contributes to a significant reduction in complications of pregnancy, and can significantly improve the condition of newborns, reducing perinatal illness [11-12,15-16].

Thus, the received results show that the use of HBO in the complex treatment of pregnant women with anemia may take place in clinical practice both for treatment of anemia during pregnancy, and for the prevention of complications of pregnancy and childbirth.

Competing interests

The authors declare that they have no competing interests.

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