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THE DIAGNOSTIC ROLE OF FETAL HEMOGLOBIN AND BLOOD OXYGEN SATURATION IN CHRONIC LIVER DISEASES

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ABSTRACT — This research aims to study levels of fetal hemoglobin and blood oxygen saturation in 264 patients with chronic diffuse liver diseases, among them 69 patients with chronic hepatitis and 195 patients with liver cirrhosis. To determine the levels of fetal hemoglobin, a patented method of rocket electrophoresis in agar gel with sodium dodecyl sulfate was used. The level of fetal hemoglobin in liver cirrhosis were significantly increased compared to chronic hepatitis, and, in both cases, compared with the control group. Oxygen saturation of the blood was reduced mainly in liver cirrhosis. In patients with liver cirrhosis a relationship between fetal hemoglobin and oxygen saturation was established. Our study helps in the early diagnosis of latent chronic hypoxia and hypoxemia in patients with liver disease. This allows to assess disease severity and adjust the treatment.

KEYWORDS — chronic hepatitis, liver cirrhosis, fetal hemoglobin, oxygen saturation, hypoxemia.

INTRODUCTION

The role of hypoxia and hypoxemia in Chronic Liver Diseases (CLD) has been well investigated by researchers. [1, 2, 3]. Hypoxia and hypoxemia in Chronic Hepatitis (CH) and Liver Cirrhosis (LC) can be both local and systemic. Inadequate oxygen supply of liver parenchyma may occur due to high vascular resistance, intrahepatic shunts, intravascular thrombosis, reduction of the area of sinusoidal capillaries [2, 3]. In turn, hypoxia and hypoxemia, becoming chronic, contribute to the progression of fibrosis and LC, deterioration in the course and prognosis of the disease [2, 4, 5].

Fetal hemoglobin (HbF) is the dominant form of hemoglobin present in the fetus during gestation. HbF is produced by erythroid precursor cells from 10 to 12 weeks of pregnancy through the first six months of postnatal life. Yet, it is also considered as one of the markers of tissue hypoxia in adults. At the same partial pressure, HbF more actively absorbs oxygen and gives carbon dioxide than adult hemoglobin (Hb) [6, 7]. Normal HbF is found in adult blood minimum concentration of 1–1.5% [7, 8]. The increase of its content, detected in a number of diseases of internal organs, is considered as an adaptive reaction of the organism, aimed at stabilization of tissue gas exchange [7]. Previously, we described the HbF concentration increase in CLD [8].

Objective:
to improve the diagnosis of hypoxia and hypoxemia in CH and LC based on the study of changes in blood levels of HbF and the degree of blood oxygen saturation.

MATERIALS AND METHODS

The study included 264 patients with CLD (138 men and 126 women aged 20 to 60 years). With CH was observed 69, with LC — 195 patients. Control group (CG) consisted of 50 healthy donors matched for age and gender.

Patients were examined in the hospital at the stage of exacerbation of their underlying disease. CH and LC was diagnosed on the basis of complaints of patients, anamnestic and clinical data, the results of laboratory and instrumental methods of examination. The diagnosis was made in accordance with the existing classifications of CH and LC.

We used individual quantitative analysis of HbF, a patented rocket electrophoresis technique in an agar gel with sodium dodecyl sulfate, in all patients with CH, LC and CG. The blood oxygen saturation (SpO2) was determined in 58 patients with CH, 115 — LC and 50 patients CG using the pulse oximeter "RM S-31". Statistical data processing was performed by the "Statistica 10.0" application package.

RESULTS AND DISCUSSION

The average values of fetal hemoglobin in patients with CH, LC and CG are presented in the Table 1.

The concentration of HbF in CG was 2.4 [1.4; 2.9] g/l, which generally corresponds to the literature data. There were no gender differences in the CG. The mean HbF concentrations measured in absolute value in the CH and LC groups did not differ significantly (3,4 [2; 4.5] g/l and 3.6 [2.4; 4.3] g/l, respectively;

Table 1. *Mean values of fetal hemoglobin in patients with chronic hepatitis, liver cirrhosis and the control group*

Indicator	Control group (n=50)	Chronic hepatitis (n=69)	Liver cirrhosis (n=195)
HbF (g/l)	2.4 [1.4; 2.9]	3,4 [2; 4.5]*	3.6 [2.4; 4.3] *
Total Hb (g/l)	143 [125; 165]	133.7[115;155]**	118.6 [90; 134]*
Percentage of HbF of total Hb (%)	1.53 [0.5; 1.7]	2.6 [1.8; 3.7]* **	3.4 [2.7; 5] *

** — the reliability of differences between patients with CH and LC compare CG<0,01*
*** — the reliability of differences between patients with CH and LC <0.01*

p>0.05), but were significantly higher than in CG (p<0.01).

Due to the frequent development of anemic syndrome in CLD, lower average values of total Hb are observed in CLD patient, compared to CG. Therefore, for an objective analysis of the data and their reliable verification, the absolute values of HbF (g/l) were converted to the percentage of HbF (%) of total Hb.

It was shown that after the transfer of the mean values of HbF in absolute values to their percentage to total Hb, there were significant differences (p<0.01) between the groups of patients with CH and LC, there was also an increase in the reliability of differences between CH and LC patients to CG.

The increase in fetal hemoglobin levels in CH and LC can be explained by the fact that, as a chromo protein evolutionarily adapted to the stabilization of tissue gas exchange in chronic hypoxia with more affinity for oxygen than adult hemoglobin, HbF reacts to chronic tissue hypoxia in liver disease. The increase in the concentration of HbF in erythrocytes occurs due to the development of adaptive reactions of erythron in hypoxia and is associated with partial depression γ-chain globin in the background of intense erythropoiesis.

To establish possible relationships of the concentrations of HbF with indicators of blood oxygen saturation in 58 patients with CH, 115 with LC, and 50 patients of CG were determined SpO_2 values.

The average level of SpO_2 in CG amounted to 98.6±0.5%. Variability values were in the range 97–99%.

The SpO_2 level in the group of patients with CH averaged 96.6±0.7%, which did not differ significantly from the norm. The mean value of SpO_2 in the group of patients with LC was 94.9±0.7%, which was significantly lower (p<0.05), compared with CH (98.6±0.5%). It should be noted that the revealed hypoxemia in the majority of patients with LC was weakly expressed: the variability of the level of SpO_2 in the LC was in the range of 92–97%.

Analysis of the study results showed that at normal values of SpO_2≥95%, the content of HbF% averaged 2.98±0.13%, while at SpO_2<95% — 3.35±0.12% (p=0.04). Consequently, with a decrease in blood oxygen saturation characterizing the development of signs of hypoxemia in LC patients, the concentration of HbF% was significantly higher than in normal indicators of SpO_2.

CONCLUSION

Detection of increased values of tissue hypoxia marker HbF and reduced blood oxygen saturation indicate the development of hypoxia and hypoxemia in CH and LC. Therefore, the study of the indicators of HbF and SpO_2 increases the effectiveness of early diagnosis of latent chronic hypoxia and hypoxemia in clinical practice for the chronic liver disease. These methods enable improving the diagnosis of disease severity and adjusting the treatment.

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