GENDER PECULIARITIES OF PROTEIN AND LIPID PEROXIDATION OF THE ORAL LIQUID UNDER THE CONDITIONS OF PRECLINICAL IODINE AND IRON DEFICIENCY

O. Zayats

Ivano-Frankivsk National Medical University, Ivano-Frankivsk, Ukraine

Abstract. The prevalence of somatic pathology in children increases significantly with each passing year, which is associated with socio-economic, environmental conditions, the complex interaction of exogenous and endogenous factors. This problem may be related to micronutrient imbalances, among which iodine deficiency and sideropenia are quite common.

Objective. The aim of the study is to learn the peculiarities of peroxidation of proteins and lipids, the system of antioxidant defence of oral fluid in conditions of preclinical iodine and iron deficiency.

Materials and Methods. The study included 115 children aged 6-18 years. The level of peroxidation of proteins was characterized by the content of oxidative modification of protein products (aldehyde derivatives of the main nature) in the oral fluid. Peroxidation of lipids of oral fluid was assessed by the accumulation of diene conjugates (DCs) of polyunsaturated fatty acids and products responding to thiobarbituric acid (TBA-RP).

Results. It has been determined that in case of iodine and iron deficiencies, their combination causes significant activation of protein and lipid peroxidation processes in the oral fluid of children, accompanied by an imbalance of the prooxidant-antioxidant system of the oral cavity.

Conclusion. Such changes can be predictors of the development of dental pathology.

Key words: *free radical oxidation of proteins and lipids, antioxidant system, oral fluid, oxidative stress.*

Problem statement and analysis of recent research.

The prevalence of somatic pathology in children increases significantly with each passing year, which is associated with socio-economic, environmental conditions, the complex interaction of exo- and endogenous factors. Iodine and iron deficiency conditions affect the mental, intellectual and physiological development and status of a person, so they can potentiate the negative impact on the body of each of them [1, 2, 3].

Particular attention is drawn to the deterioration of dental status in school-age children. Such a tendency may arise from oxidative stress occurring as a result of physiological imbalance of antioxidant protection (AOP), protein peroxidation (PPO) and lipid peroxidation (LPO). Scientific publications sufficiently cover the patterns of development of LPO processes, their influence on the development of inflammation, pathogenesis of hypoxia, violation of vascular wall resistance, which may be the cause of gingivitis and periodontitis [4]. Equally important role in the development of disorders of dental status belongs to the oxidative modification of proteins (OMP). The manifestation of these processes causes the destruction of cell membranes [5, 6, 7]. Diene conjugates (DCs) are highly toxic aldehyde molecules that act as sensitive markers of lipoperoxidation. However, in the process of PPO, cell apoptosis occurs due to secondary lipid damage. The level of OMP is more informative than the indicators of LPO under oxidative stress [8,9,10,11].

Objective. Study of the peculiarities of peroxidation of proteins and lipids, the system of antioxidant protection of oral fluid in preclinical iodine and iron deficiency.

Material and methods

For the study there were examined 115 children (58 boys and 57 girls) aged from 6 to 18 years. All children were divided into four groups: control group (group 1, n = 28), schoolchildren with mild iodine deficiency – MID (group 2, n = 29), latent iron deficiency – LID (group 3, n = 28) and combined iodine and iron deficiency – MID and LID (group 4, n = 30). Schoolchildren in the control group had a proper

metabolism of iodine and iron. The diagnosis was made on the basis of complaints of the studied pupils, medical history and clinical and laboratory methods of research. Groups of children were randomized for gender and clinical diagnosis based on age (6-11 and 12-18 years). To determine the state of iodine supply, there was determined the concentration of iodine in the urine of children according to the method of Dunn and co-authors [12]. In conditions of mild iodine deficiency, the iodine content in the urine was in the range of 50-99 $\mu\text{mol/l}$. LID was diagnosed under conditions of depletion of the transport and tissue fund of iron in the condition of physiological norm of hemoglobin content in the blood [13, 14]. To assess the transport fund of iron in children, the level of serum iron was determined by colorimetric method, the total iron-binding capacity of blood serum – by photometric method. The state of the iron depot was characterized by the level of serum ferritin.

The level of PPO was characterized by the content of OMP products (aldehyde derivatives of the basic nature) in the oral fluid [15,16]. The state of free radical oxidation of lipids in oral fluid was assessed by the accumulation of DCs of polyunsaturated fatty acids and products that react with thiobarbituric acid (TBA-AP).

Statistical analysis of the results was performed using computer programs Microsoft Excel and Statistica 5.5. The difference at $P < 0.05$ was considered statistically significant.

Results and discussion

As a result of the study, there was observed an increase in the content of OMP products in the oral fluid of children aged 6-11 years (Table 1). In particular, under the conditions of LID, an increase in the level of OMP was found in girls almost twice ($p_{1,2} < 0.01$), in boys – three times ($p_{1,2} < 0.001$) as for the control data. Schoolgirls with LID showed a 1.5-fold increase in OMP ($p_{1,3} < 0.001$) relative to control. The reduction at 85.2% ($p_{2,3} < 0.001$) of the content of OMP products in the oral fluid of girls of the group 3 regarding the group 2, attracts attention. Boys in the same group showed an increase at 83.0% ($p_{1,3} < 0.01$) relative to control and a

Table 1. The content of peroxidation products of proteins and lipids of the oral fluid in children with proper metabolism of iodine and iron, mild iodine deficiency (MID), latent iron deficiency (LID) and when combined (MID + LID) aged from 6-11 years (M±m)

Indexes	experimental group 1 (control)		experimental group 2 (MID)		experimental group 3 (LID)		experimental group 4 (MID+LID)	
	Boys (n=7)	Girls (n=7)	Boys (n=8)	Girls (n=7)	Boys (n=7)	Girls (n=7)	Boys (n=8)	Girls (n=7)
OMP (E_{430} nm), cu	0.043±0.002	0.032±0.001	0.134±0.02 $p_{1-2}<0.001$	0.061±0.009 $p_{1-2}<0.01$	0.052±0.02 $p_{1-3}<0.01$ $p_{2-3}<0.001$	0.052±0.001 $p_{1-3}<0.001$ $p_{2-3}<0.001$	0.143±0.02 $p_{1-4}<0.001$ $p_{3-4}<0.001$	0.070±0.001 $p_{1-4}<0.001$ $p_{2-4}<0.001$ $p_{3-4}<0.001$
DC, cu/ml	0.29±0.06	0.307±0.048	0.37±0.05	0.448±0.12	0.67±0.09 $p_{1-3}<0.01$ $p_{2-3}<0.05$	0.569±0.15	0.506±0.04 $p_{1-4}<0.01$ $p_{2-4}<0.05$	0.54±0.14
TBA-RP, nmol/ml	0.59±0.054	0.74±0.1	0.83±0.08 $p_{1-2}<0.05$	8.71±2.59 $p_{1-2}<0.001$	0.83±0.09 $p_{1-3}<0.05$	7.58±1.15 $p_{1-3}<0.001$	0.75±0.12	9.14±1.17 $p_{1-4}<0.001$

Note: here and in Table 2: p – significant differences between the respective experimental groups

2.5-fold decrease ($p_{2-3}<0.001$) – as for the data from peers of the group 2. OMP products are stable in contrast to PPO products, so they are markers of tissue damage. They are also a source of free radicals, which deplete the antiradical reserve leading to disruption of the structure and function of cell membranes against the background of which there may be dental pathology [12, 13].

Intensive activation of protein peroxidation of the oral fluid was observed in boys and girls with combined microelementosis. Thus, in girls of the group 4 the level of OMP products in the oral fluid increased 2.2 times ($p_{1-4}<0.001$), and in boys – 3.3 times ($p_{1-4}<0.001$) relative to control values. The unidirectional changes in the content of OMP products in the oral fluid of children with combined microelementosis in relation to the data in children of the groups 2 and 3 (schoolchildren with isolated iodine and iron deficiency) attract attention. Thus, the content of OMP products in the oral fluid of girls with MID and LID was 87% higher ($p_{2-4}<0.001$) than under MID conditions and almost 1.5 times ($p_{3-4}<0.001$) than under LID conditions. In boys of the group 4, the 2.7-fold growth of OMP products in the oral fluid was observed ($p_{3-4}<0.001$) compared to the data in the group 3. Considering the high informativeness of the protein lipoperoxidation index, it can be argued that the presence of oxidative stress in the body of children who were under observation. Iodine deficiency is a risk factor for activation of PPO processes, especially in boys of pubertal age. Such results may characterize the accumulation of free radicals in the oral fluid gathering in various pathological conditions. When performing a comparative analysis of markers of LPO processes, it was found that the content of DCs 1.3-fold exceeded the control values in boys with LID ($p_{1-3}<0.01$), with combined microelementosis – 1.8-fold ($p_{1-4}<0.01$) regarding control. The index of DCs in the oral fluid of boys of the groups 3 and 4 exceeded the value of the indicator under the conditions of LID almost twice ($p_{2-3}<0.05$) and 1.5-fold ($p_{2-4}<0.05$). Under such conditions, the level of DCs in girls changed insignificantly.

In girls of this age group, an increase in TBA-AP in the oral fluid was observed: under conditions of MID – almost

12-fold ($p_{1-2}<0.001$), LID – 10-fold ($p_{1-3}<0.001$), combined pathology – 12-fold ($p_{1-4}<0.001$) relative to the data of the control group. In boys there were found unidirectional changes, in particular, an increase in the content of TBA-AP in the oral fluid of the experimental groups 2 and 3 by almost 1.5-fold ($p_{1-2}<0.05$, $p_{1-3}<0.05$) relative to the data in healthy peers. Such dynamics reflects a significant accumulation of LPO products in the oral fluid under the conditions of preclinical stages of iodine and iron deficiency, as well as their combination. In general, lipoperoxidation processes in boys were inert, while in girls with microelementosis the content of LPO products increased significantly (especially due to TBA-AP). When analyzing the indicators of protein and lipid peroxidation of the oral fluid in schoolchildren aged from 12-18 years, attention is also drawn to the changes in oxygen-dependent processes, which were multidirectional in some cases (Table 2). In particular, girls with LID had an increase in the level of OMP (1.5-fold, $p_{1-3}<0.05$ relative to control and 1.8-fold, $p_{2-3}<0.05$ relative to the data of the group 2). In girls with combined iodine and iron deficiency, this indicator increased almost twice relative to the control group ($p_{1-4}<0.05$) and group 3 ($p_{3-4}<0.001$), respectively. In young men, the activation of PPO was not so pronounced. The increase in the level of OMP products in adolescents of the groups 2 (MID) and 4 (MID + LID) twice ($p_{1-2}<0.01$, $p_{1-4}<0.05$), relative to basic data can also draw attention.

At the same time, the intensity of lipoperoxidation processes in girls was slightly lower than in boys, but remained at a fairly high level as for the control. Thus, the level of DCs in the oral fluid of girls of the groups 3 (LID) and 4 (MID + LID) increased almost twice ($p_{1-3}<0.01$, $p_{1-4}<0.01$) relative to basic values. Such data exceeded the index in girls of the group 2 at 78% ($p_{2-3}<0.05$, $p_{2-4}<0.05$). There were also observed an increase in the level of DCs in the oral fluid in young men of all groups: group 2 (LID) – 1.5-fold ($p_{1-2}<0.05$), group 3 (LID) and group 4 (MID + LID) – almost twice ($p_{1-3}<0.01$, $p_{1-4}<0.001$) relative to control.

Under conditions of micronutrient imbalance in male adolescents of the group 2 there was found a 1.5-fold increase in the level of TBA-AP ($p_{1-2}<0.001$) relative to control data.

Table 2. The content of peroxidation products of proteins and lipids of the oral fluid in children with proper metabolism of iodine and iron, mild iodine deficiency (MID), latent iron deficiency (LID) and when combined (MID + LID) aged from 6-11 years (M±m)

Indexes	experimental group 1 (control)		experimental group 2 (MID)		experimental group 3 (LID)		experimental group 4 (MID+LID)	
	Boys (n=7)	Girls (n=7)	Boys (n=8)	Girls (n=7)	Boys (n=7)	Girls (n=7)	Boys (n=7)	Girls (n=8)
OMP (E ₄₃₀ nm), cu	0.036±0.002	0.55±0.05	0.079±0.01 p ₁₋₂ <0.01	0.604±0.05	0.053±0.01	0.35±0.08 p ₁₋₃ <0.05 p ₂₋₃ <0.05	0.07±0.01 p ₁₋₄ <0.05	0.07±0.01 p ₁₋₄ <0.05 p ₃₋₄ <0.001
DC, cu/ml	0.34±0.03	0.313±0.07	0.505±0.06 p ₁₋₂ <0.05	0.51±0.07	0.65±0.04 p ₁₋₃ <0.01 p ₂₋₃ <0.05	0.61±0.07 p ₁₋₃ <0.01	0.66±0.03 p ₁₋₄ <0.001 p ₂₋₄ <0.05	0.62±0.04 p ₁₋₄ <0.01
TBA-RP, nmol/ml	1.02±0.04	1.05±0.18	1.61±0.03 p ₁₋₂ <0.001	1.56±0.17 p ₁₋₂ <0.05	1.63±0.02 p ₁₋₃ <0.001	1.64±0.04 p ₁₋₃ <0.01	1.66±0.11 p ₁₋₄ <0.001	1.58±0.11 p ₁₋₄ <0.05

The same unidirectional changes (almost 1.5-fold increase, p₁₋₂<0.05, p₁₋₃<0.01, p₁₋₄<0.05) were found in the oral fluid of girls of all experimental groups relative to baseline.

Our studies in preclinical iodine and iron deficiency in oral fluid indicate significant changes in its homeostasis. The highest processes of protein and lipid peroxidation were in the oral fluid of children of the experimental group 4, age category 6-11 years. It can be assumed that one of the main reasons for the development of inflammatory-destructive changes in the organs of the oral cavity may be the effect of excessive free radical oxidation of proteins and lipids of the oral fluid. It should be emphasized that the violation of physiological peroxidation of proteins and lipids of oral fluid may be due to the deficiency of iodine and iron.

Conclusion

It has been determined that MID, LID and their combination cause the significant activation of protein and lipid peroxidation processes in children's oral fluid and can be the predictors of dental pathology. Such changes may occur against the background of weakening of anti-radical protection. The development of oxidative stress can lead to vascular disorders that will affect the dental health of schoolchildren.

Prospects for further research are to perform a clinical examination of these children data, to establish the dental status and study of antioxidant homeostasis, calcium metabolism in the oral fluid.

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