EXPERIMENTAL BIOLOGY

Lipid Peroxidation—Antioxidant Activity System in Erythrocytes of Patients with Chronic Bronchitis Inhaling and Not Inhaling Ozone

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Development of chronic bronchitis in individuals chronically exposed to ozone is associated with complex changes in the lipid peroxidation—antioxidant activity system in erythrocytes characterized by intensification of lipid peroxidation and parallel attenuation of antioxidant activity.

Key Words: *ozone; lipid peroxidation; antioxidant activity; chronic bronchitis*

Lipid peroxidation—antioxidant activity ((LPO—AOA) system is now believed to play an important role in the course of normal and pathological processes [1-3]. Various disturbances in this system underlie the development of polymembrane abnormalities [1]. The presence of LPO—AOA system was revealed in cell membranes in the lungs [2], while the development of asthma, acute pneumonia, and chronic bronchitis (CB) is associated with changes in this system, *e.g.* in erythrocyte membranes [1,3].

The aim of the present study was to evaluate the state of the LPO—AOA system in erythrocytes in patients with CB inhaling and not inhaling a very toxic oxidant ozone.

MATERIALS AND METHODS

We examined 196 workers employed at a plastisizer plant and occupationally exposed to ozone and 75 city residents not exposed to ozone. All of them had different forms of CB in remission (prebronchitis, PB; chronic nonobstructive bronchitis, CNB; chronic obstructive bronchitis, COB). Control group consisted of 50 healthy subjects.

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LPO products (lipid hydroperoxides, conjugated dienes, conjugated ketotrienes, and Schiff bases) were measured as described previously [7] and their content in erythrocyte suspension was expressed in arbitrary units (E_{232}/E_{220}, E_{278}/E_{220}, and E_{400}/E_{220}, respectively). The concentration of malonic dialdehyde (MDA) was evaluated by the reaction with thiobarbituric acid [5]. Activities of antioxidant enzymes (AO) catalase, superoxide dismutase (SOD), glutathione peroxidase and glutathione reductase were measured as described previously [4]. The total status of the erythrocyte LPO—AOA system was evaluated by the weighted mean difference (in %) between the levels of LPO products and AO content in erythrocytes.

RESULTS

In workers with PB the content of LPO products in erythrocytes was increased in comparison with healthy controls: after 5-year service this parameter 2.2 times surpassed that after 2-year service (Table 1). AOA in erythrocytes also decreased in comparison with the control with increasing the length of service.

In patients with CNB, the formation of LPO products in erythrocytes was more intensive than in healthy controls, the degree of this increase depended on

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the length of service. This parameter increased 1.9 times in workers with length of service from 3 to 6-7 years, in workers with longer service it decreased 2.4-fold, but even after 10 and more years of work the content of LPO products in erythrocytes remained above the control. The mean intensity of LPO processes in workers with CNB 1.9-fold surpassed that in PB, which was paralleled by progressive decrease (by 3.2 times) in AOA in erythrocytes with increasing the length of service. The mean AOA in workers with CNB was far lower than in workers with PB.

The maximum increase in the level of LPO products in comparison with healthy controls was detected in erythrocytes of patients with COB. This increase also depended on the length of service. In workers employed for 5-7 years the level of LPO products was 1.2 times increased, but by 10 years of work it decreased 2.2 times. AOA in erythrocytes of these patients was below the control level during all years of work, and this decrease became 1.7-fold more pronounced from the 5th to 10th year of service. The intensity of LPO in erythrocytes of workers with COB was higher than in workers with PB and CNB (2.4- and 1.2-fold, respectively). AOA was 1.7-fold lower in workers with COB than in those with CNB.

In city residents with PB we observed slight activation of LPO processes in erythrocytes, particularly at the age of 36-40 years, but AOA in erythrocytes did not differ from that in healthy controls in all age groups. The decrease in the content of LPO products in erythrocytes was 11.6-fold less expressed in city residents with PB in comparison with workers with PB.

The difference in LPO intensity between city residents with CNB and healthy controls increased and peaked at the age of 41-45 years. The difference in the content of LPO products between city residents with CNB and healthy controls was 3.4 times more than between city residents with PB and healthy controls, but 6.4 times less than between workers with CNB and healthy controls. AOA in erythrocytes from these patients was lower than in controls, but 3.4 times higher than in workers with CNB.

LPO processes were the most intensive in erythrocytes of city residents with COB, the maximum difference from controls being observed at the age of 36-40 years. LPO processes in city residents with COB were 9.9- and 2.9-fold more intensive than in patients with PB and CNB, respectively, but 2.8-fold less intensive than in workers with COB. AOA in erythrocytes of city residents with COB differed more distinctly from the control in comparison with other forms of CB, but little changed with age. The mean difference in AOA in erythrocytes between city residents with COB and healthy controls was 2.2 times more pronounced than between city residents with CNB and controls, but 2.6 times less expressed than between city residents with COB and workers with COB.

Therefore, irrespective of occupational exposure to ozone, progression of CB was accompanied by intensification of LPO in erythrocytes and attenuation of AOA, but these changes were more pronounced in workers. This means that occupational exposure to ozone caused more pronounced disturbances in the LPO—AOA system in erythrocytes in comparison with patients not exposed to ozone.

Our findings suggest that decreased AOA in erythrocytes is one of the main causes of LPO intensification in erythrocytes of patients with CB.

The changes in the levels of LPO products in erythrocytes of workers with PB with various length

TABLE 1. Weighted Mean Changes in LPO Products/AO Enzymes (% of Those in Healthy Controls) in Erythrocytes of Workers and City Residents with Various Forms of CB

Age, length of service, years		Workers			City residents		
		PB	CNB	COB	PB	CNB	COB
26-30	2	+78/+9	—/—	—/—	+3/0	—/—	—/—
31-35	3	+74/+4	+168/-9	—/—	+6/-1.0	+20/-4	—/—
36-40	4	+153/+2	+193/-9	—/—	+20/+0.3	+32/-5	+114/-10
	5	+176/+1	+295/-12	+309/-19	—/—	—/—	—/—
	6	—/—	+310/-14	+365/-23	—/—	—/—	—/—
41-45	7	—/—	+300/-16	+363/-28	—/—	+55/-5	+103/-12
	8	—/—	+216/-22	+266/-33	—/—	—/—	—/—
46-50	9	—/—	+140/-25	+164/-33	—/—	+30/-7	+80/-12
	10 and more	—/—	+128/-29	+165/-33	—/—	—/—	—/—
Total		+116/+4	+219/-17	+272/-28	+10/-0.5	+34/-5	+99/-11

of service in comparison with healthy controls are in similar, while in workers with CNB and COB these changes are asynchronous and heterochronous. Asynchronism and heterosynchronism of age-associated differences in the content of LPO products in comparison with the control were observed in city residents with various forms of CB. Therefore, the time course of differences from the control in the content of LPO products in erythrocytes in CB patients exposed and not exposed to ozone is similar, which indicates stereotypy of these changes, *i.e.* they occur irrespective on occupational exposure of CB patients to ozone.

The difference in erythrocytic AO between workers with PB and healthy controls was virtually the same in groups with different length of service, but with the development of CNB changes of some AO become asynchronous and thus remain in workers with COB.

No asynchronous age-associated changes in the levels of erythrocytic AO in comparison with healthy controls were observed in city residents with all forms of CB.

Hence, the dynamics of differences in the content of LPO products and AO in erythrocytes of workers and city residents in comparison with the control is different, indicating different dynamics of LPO—AOA system components in erythrocytes. The reaction of MDA to CB in workers was minimum, while conjugated ketotrienes and Schiff bases were much more reactive. The same regularity was observed in city residents with CB. Therefore, changes in individual LPO products in humans with bronchopulmonary disease exposed and not exposed to ozone were similar.

Asmong AO enzymes, catalase first and most actively reacts to CB both in workers and city residents.

These data indicate that CB is associated with complex changes in the LPO—AOA system, which are characterized by intensification of LPO processes and suppression of AOA. These changes were more pronounced in CB patients occupationally exposed to ozone compared to those who had no contacts with ozone.

According to modern concepts, disorders in the LPO—AOA system belong to the most important typical pathological processes [6], and presumably the detected deviations in its function in CB patients are involved in the pathophysiological mechanisms of its development.

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