Effects of Ozone Exposure on Lipid Peroxidation and Anti-oxidative Systems in Rats Subjected to Physical Exercise

ISAMU ICHIKAWA and EIJI YOKOYAMA

Department of Industrial Health, The Institute of Public Health, 4-6-1 Shirokanedai, Minato-ku, Tokyo 108, Japan

Photochemical smog is believed to cause health problems among residents and schoolchildren in polluted areas, especially during physical exercise in the summer. The main components of photochemical oxidant, which are ozone (O_3) and nitrogen oxides, can oxidize unsaturated fatty acids. Several studies on alterations in the level of lipid peroxide caused by physical exercise have been reported but little work has been done on the biochemical effects of a combination of physical exercise and oxidative gases such as O_3 . In the present study, we examined the effects of O_3 exposure on the level of lipid peroxide, the lipid peroxidation in microsomes, the activities of anti-oxidative enzymes and the level of anti-oxidative vitamins in some organs of rats subjected to physical exercise.

Twelve 4-week-old Jcr: Wistar strain male or female rats were forced to run on a treadmill, at the five rates from 20 m/min for 15 min to 35 m/min for 60 min, during 5 weeks. Twelve other male or female rats were not made to exercise.

The day after the last exercise period 6 of 12 rats in both groups were exposed to O_3 (1 ppm) for 24 h in a chamber. After anesthesia with Nembutal®, the animals were sacrificed and the contents of malondialdehyde (MDA), total ascorbic acid (V.C) and alpha-tocopherol (V.E) in homogenates of lung, liver, kidney, brain and adrenal and in plasma and blood cells were determined.

The activities of superoxide dismutase (SOD), cata-

lase (CAT) and glutathione peroxidase (GPO) were assayed in the supernatant fractions. To examine the ability to produce conjugated dienes and MDA and the activity of NADPH-dependent cytochrome c reductase in the microsomes, a mixture of ADP, $FeCl_3$, NADPH and microsomal fraction was incubated at 37°C.

The differences in body weight (BW) of male and female rats between the exercise and the rest groups were 50 and 20 g, respectively. The degree of loss in BW was greater after the O_3 exposure. In the exercise group, the weights of the lung, liver and kidney of males and of the liver of females were decreased, and greater losses of liver and kidney weights of males and of lung weight of females were observed after the O_3 exposure.

In the lung of males and plasma of females, the increase in the level of MDA caused by the O_3 -exposure was suppressed in the group subjected to exercise prior to the exposure to O_3 . The dependency of decrease in the brain MDA level of male rats was observed in the groups of exercise and O_3 -exposure. These alterations in the level of MDA might be influenced by the level of V.C. On the other hand, the increase in the liver MDA level of both male and female rats caused by the O_3 exposure might be related to the decreases in the activity of CAT and in the content of V.E. These biochemical effects of physical exercise and exposure to O_3 were greater in male rats than in females.

From these results, it is suggested that physical exercise reduces the production of lipid peroxide upon exposure to O_3 in some organs, and, because alterations in the ability to produce lipid peroxides in the microsomes and in the activities of anti-oxidative enzymes after exposure to O_3 were very slight, it is further suggested that the mechanism of lipid peroxidation by O_3 is different from that by active oxygens.