ACTIVITY OF MONOAMINE OXIDASE IN THE HYPOTHALAMUS OF EWES AFTER PROTRACTED EXPOSURE TO GAMMA RADIATION

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Abstract

The investigated changes in monoamine oxidase (MAO) activity in the hypothalamus of ewes in the anoestrous period exposed to a whole body 60Co irradiation with a total dose of 6.7 Gy for the period of 7 days were investigated. The radiation increased significantly the activity of MAO in the caudal, medial and rostral hypothalamus of the investigated ewes. It may be assumed that an increased degradation of catecholamines caused by MAO is one of the mechanisms responsible for the pronounced changes in the level of catecholamines in the hypothalamus of ewes after irradiation.

Key words: ewes, gamma radiation, monoamine oxidase, pituitary gland.

Ionizing radiation affects considerably the levels of catecholamines and serotonin in the hypothalamus, whole brain, heart and adrenals of irradiated animals (8, 11) and causes damage to the mechanisms of accumulation and retrograde uptake of catecholamines by adrenergic neurons. Decreased levels of catecholamines persist also in post-irradiation periods and their return to original values is hard to achieve (10). One of the factors that influence the changes in concentration of catecholamines after exposure to gamma radiation is the damage to mechanisms of their synthesis and degradation. Mitochondrial monoamine oxidase (MAO) is an enzyme that plays an important role in the degradation of catecholamines and serotonin in the CNS in terms of the catalysis of oxidative deamination of catecholamines. Monoamine oxidase is located on the outer membranes of norepinephrine-containing synaptic vesicles and is most likely responsible for its intraneuronal metabolism.

Our studies (7, 8) revealed that continuous irradiation of sheep with gamma rays at a dose of 6.7 Gy decreases the concentration of catecholamines and the precursor of their synthesis, L-dopa, in the hypothalamus and hypophysis. The present study aimed to define the changes in the activity of MAO and concentration of catecholamines in the hypothalamus of sheep after protracted exposure to gamma radiation.

Material and Methods

The experiment was carried out on 12, 2-3 years old Slovak Merino sheep with the mean body weight of 40±5 kg, in the anoestrous period (May). Control group consisted of six sheep. The experimental animals (n=6) were all body-irradiated continuously for seven days until the total dose of 6.7 Gy was reached. The hourly input of the radiation source 60Co was 0.039 Gy. The sheep were kept in cages at a distance of 4.6 m from the source. After irradiation, the sheep were killed by bleeding and the samples of hypothalamus were collected immediately. The hypothalamus was divided by segment analysis to rostral, medial, and caudal parts and was stored in liquid nitrogen before further processing. The tissue was homogenized in Potter-Elvehjem glass homogenizers in cooled saccharose at a concentration of c = 0.25 mol L-1. A 25 μl aliquot of the homogenate was used to determine the activity of MAO and protein content. The activity of MAO was determined by the radiochemical method of Wurtman and Axelrod (13) using 14C-tryptamine of specific activity of 18.5·10-7 Bq nmol-1 as a substrate (6.25 nmol of 14C-tryptamine were used per one sample). The activity was measured in a scintillation Packard TRI CARB spectrometer in 14C column. The results were presented in pmol of product (14C-dihydroxyphenylacetaldehyde) mg protein-1 min-1 and were evaluated statistically by non-paired t-test as arithmetic means ± S.E.M. A method according to Lowry (6) was used to determine protein content.

Results

The obtained results indicate that the activity of MAO in the investigated sheep hypothalamus regions...
differed. In the anoestrus period, it reached 900 ± 8.65 pmol.mg⁻¹.min⁻¹ in the rostral region, 850 ± 7.6 in medial, and 550 ± 3.13 pmol.mg⁻¹.min⁻¹ in the caudal region of the hypothalamus. The lowest observed activity was 320 pmol. The whole-body irradiation increased MAO activity in the caudal hypothalamus by 100% compared to the intact control group. The medial and rostral regions showed lower but also significant rise by 30.6% and 22.2%, respectively (Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>The activity of monoamine oxidase in the hypothalamus of control and whole-body irradiated ewes</th>
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<tbody>
<tr>
<td></td>
<td>hypothalamus</td>
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<tr>
<td>rostral</td>
<td>900 ± 8.65</td>
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<tr>
<td>medial</td>
<td>850 ± 7.60</td>
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<tr>
<td>caudal</td>
<td>550 ± 3.13</td>
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* P < 0.05 means ± S.E.M.
** P < 0.001.

Discussion

Intraneuronal MAO plays an important role in the regulation of functionally active pool of catecholamines in CNS and is probably essential for maintenance of their cytoplasmic level at the lowest point of the neuron. Single whole-body irradiation of animals with ⁶⁰Co resulted (2) in marked metabolic changes including the levels of catecholamines, serotonin and acetylcholine in the brain, heart and adrenal glands of the laboratory animals. Some authors (2) observed also changes in the activity of enzymes participating in the synthesis and degradation of catecholamines. Our results can only be compared with those obtained for the laboratory animals. After protracted whole-body exposure to gamma-radiation (total dose of 6.7 Gy) a significant increase in the activity of MAO was observed in the caudal hypothalamus compared to the control levels. The activity of MAO in the irradiated medial region (6.7 Gy) increased insignificantly (by 20.9%). The rostral hypothalamus showed no changes compared to the control. Adolfson et al. (1) observed an increase in MAO activity by 65.5% in a non-differentiated brain of rabbits exposed to a single-dose whole-body gamma irradiation of 400 R. Other authors (3, 9) observed no significant changes in MAO in the heart of guinea pigs and mice 30 min after local irradiation of these animals with gamma rays at doses from 250 to 6000 R. The differences in the data of various authors may be ascribed to the fact that exposure to a local single-dose ionizing radiation causes less pronounced changes in the level of catecholamines and MAO activity than exposure to protracted whole body irradiation with the same dose (4, 5, 9).

The decrease in the level of catecholamines in the hypothalamus of irradiated ewes may be related to a damage to metabolic processes and endothelium of vessels and to a decrease or restraining of catecholamine synthesis (11), decrease in their peripheral sources and increase in the activity of MAO, the enzyme which participates considerably, together with catechol-o-
methyltransferase, in the degradation process of catecholamines in the central nervous system.

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References


