ECOLOGY

Morphological and Histochemical Changes in the Thyroid Gland after a Single Exposure to 2,4-DA Herbicide

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Pathomorphological and quantitative histochemical studies revealed injury and changes in the membrane transport and synthetic processes in the thyroid gland of rats after acute exposure to herbicide 2,4-DA (2,4-dichlorophenoxyacetic acid amine salt).

Key Words: *2,4-DA; thyroid gland; histochemistry*

Environmental pollution with dioxin and dioxin-containing products is a pressing problem all over the world [6-8]. Reports about dioxin enhancement of toxic effects of many chemicals stimulated studies of the effects of complex dioxin-containing mixtures on the endocrine system, which is known to be sensitive to such compounds [2].

We investigated the herbicide 2,4-DA (2,4-dichlorophenoxyacetic acid amine salt), a dioxin-containing compound [3,5,6] widely used in national economy.

Our aim was to assess thyroid gland morphology and function after acute experimental poisoning with 2,4-DA.

MATERIALS AND METHODS

Sixty male albino rats weighing 150-200 g were administered 40% suspension of 2,4-DA through a gastric tube in doses 1/2 (290 mg/kg), 1/10 (59 mg/kg), and 1/20 LD_{50} (28 mg/kg). The animals were decapitated 24 h after the beginning of experiment. One lobe of the thyroid gland was fixed in neutral formalin, embedded in paraffin, and stained with hematoxylin and eosin. The other lobe was frozen in isooctane cooled with liquid nitrogen, after which histoenzymological study of 10-μ cryostat slices was carried out.

Activities of acid and alkaline phosphatases and NADH and NADPH dehydrogenases (DH) were assayed by the method of Berston [1], iodide peroxidase was measured by the method of Van Deycke using benzidine, and hormone precursors were visualized by the PAS reaction [1].

Quantitative histochemical analysis was carried out by cytospectrophotometry using an MT-9 television microscope (LOMO, Russia). All numerical values were statistically processed by Student's test.

RESULTS

Edema, loosening of periglandular fat, and increased number of follicles were observed in all experimental groups. Follicles differed in size, the round ones contained decreased amount of colloid, and often looked empty. Focal hyperplasia of extrafollicular epithelium with formation of microfollicles was observed. Follicular epithelium was unevenly high. Disintegration of follicular epithelial complexes with its desquamation and focal lymphohistiocytic infiltration were observed. Thyrocyte cytoplasm looked clear.

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Thus, morphological picture is heterogeneous, signs of functional strain in the thyroid gland are combined with focal glandular parenchymatous lesions. Qualitative and quantitative histochemical tests with thyroid gland tissue showed dose-dependent functional shifts.

Analysis of transendothelial transport in the thyroid gland (activity of alkaline phosphatase) showed a significant suppression of membrane transport in the thyroid microvessels after all doses.

After a dose of 1/2 LD_{50}, the activity of alkaline phosphatase decreased by 33% *vs.* the control; doses of 1/10 and 1/20 LD_{50} decreased the activity of this enzyme by 17% (Fig. 1).

Measurements of the thyroid gland acid phosphatase, which is believed to participate in thyroglobulin accumulation in follicular lumen and in cleavage of endogenous protein containing hormone precursor, also showed its decreased (by 12%) activity in comparison with the control [4]. The activity of hydrolytic enzymes is a reliable marker of thyroid gland function, indicating that the thyroid gland is sensitive to 2,4-DA [4].

Measurements of NADH-DH and NADPH-DH, enzymes that reflect the status of mitochondrial and extramitochondrial energy supply of thyrocytes showed no changes in the activities of these enzymes under the effects of the doses studied.

The level of PAS-positive substance in thyrocytes decreased in all experimental groups: by 34% after a dose of 1/10 LD_{50} and by 12% after other doses. The activity of iodide peroxidase in the thyroid gland of experimental animals decreased by 15-17% *vs.* the control, this decrease being dose-dependent (Fig. 1).

Thus, comprehensive analysis of the thyroid gland of albino rats subjected to acute poisoning with 2,4-DA herbicide showed specific morphofunctional restructuring of the thyroid.

Our data indicate that the thyroid is sensitive to 2,4-DA under conditions of acute experiment in all test groups. Suppression of the activities of alkaline and acid phosphatases and of iodide peroxidase, as well as a low content of PAS-positive substance in thyrocytes indicate a decrease in the thyroid gland transport and production functions and impairment of hormone iodination in the thyroid, which probably reflects injury to the gland.

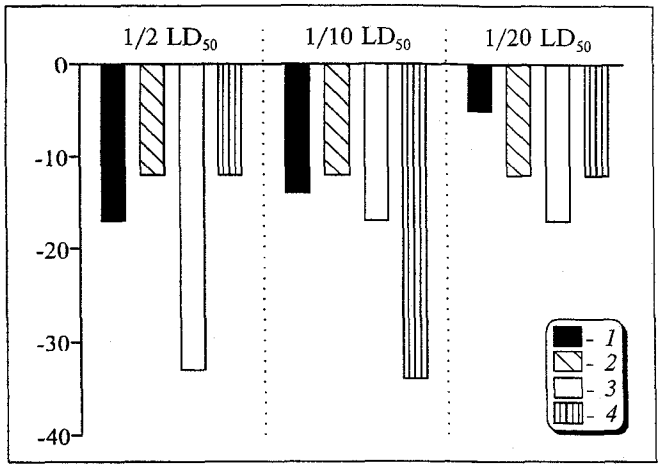

Fig. 1. Changes in activity of thyroid gland enzymes and in glycoprotein content in the thyrocytes of rats after a single exposure to the herbicide 2,4-DA. Ordinate: enzyme activity, optical density units, % of control; abscissa: reference values of enzymes. *1*) iodide peroxidase; *2*) acid phosphatase; *3*) alkaline phosphate; *4*) PAS-positive substance.

We observed no suppressive effect of 2,4-DA on the thyrocyte energy potential, which disagrees with published reports [3].

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