ROLE OF THE MAST CELLS IN PEROXIDASE ACTIVITY OF THE THYROID GLAND IN EXPERIMENTAL BURNS

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A study of the morphological and functional state of the thyroid gland during the development of experimental burns revealed fluctuating changes in the peroxidase content in the epithelial cells of the follicles and high and stable activity of this enzyme in the mast cells. The parallel observed between the localization and functional activity of the mast cells and the presence of peroxidase in the follicles suggests that the mast cells play a role in the transmission of peroxidase to the follicular cells of the thyroid gland.

The mast cells are known to synthesize heparin, histamine, serotonin, and various enzymes which are of biological importance and, at the same time, differ in their physiological actions [4-6]. Enzymes secreted by the mast cells not only function intracellularly, but also participate in the metabolism of the surrounding tissue [12]. This is confirmed by biochemical and histochemical investigations which have shown that the thyroid mast cells, which secrete chymotrypsin-like substances and, in particular, alkaline protease into the interfollicular spaces, are responsible for the hydrolysis of thyroglobulin [8].

Since peroxidase catalyzes the liberation of iodine from inorganic iodides and thereby participates in thyroglobulin synthesis [7, 10], in the present investigation the role of the tissue mast cells of the thyroid gland in the peroxidase activity of the thyroid parenchyma was studied.

EXPERIMENTAL METHOD

Experiments were carried out on 46 male albino rats on which a standard steam burn was inflicted on the epilated surface of the back. The animals were sacrificed 1, 3, 6, 12, 24, 48, and 72 h after thermal trauma. Peroxidase was detected in freshly frozen sections of the thyroid gland stained by the method of Robertis and Grasso [10]. The morphological and functional state of the mast cells was determined by staining freshly frozen and paraffin sections in 0.5% toluidine blue solution in Michaelis buffer (pH 5.0). To investigate the presence of peroxidase in mast cells of other organs, total preparations of the omentum and mesentery and frozen sections of the base of the tongue were stained by the same methods, for these organs in rats are rich in mast cells [2].

EXPERIMENTAL RESULTS

Mast cells were discovered in the thyroid gland of intact rats in the interfollicular spaces and beneath the capsule, in agreement with data in the literature [12] on the localization of the mast cells in the rat thyroid gland. The cells were mainly compact, and only individual forms in the peripheral part of the gland were granulated and degranulated. All the mast cells gave metachromasia and a strong reaction for peroxidase (Fig. 1a, b). Weak activity of the enzyme was detected throughout the cytoplasm in the epithelial cells of the follicles.

In mast cells in total preparations of the omentum and mesentery and sections through the base of the tongue, a strong reaction for peroxidase likewise was found (Fig. 1c, d).

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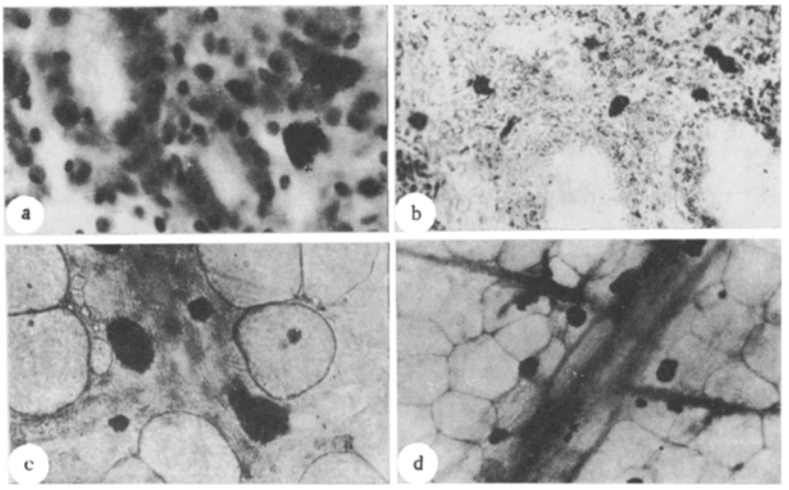

Fig. 1. Mast cells in thyroid gland and in total preparations of the omentum of intact rats: a) strong metachromasia and granulation of mast cells in interfollicular spaces of the thyroid gland; b) peroxidase activity in mast cells of the thyroid gland; c) in a lymph gland; d) along the course of the omental vessels. a) Stained with toluidine blue, 720 ×; b, c, d) stained by the method of Robertis and Grasso, 320 ×.

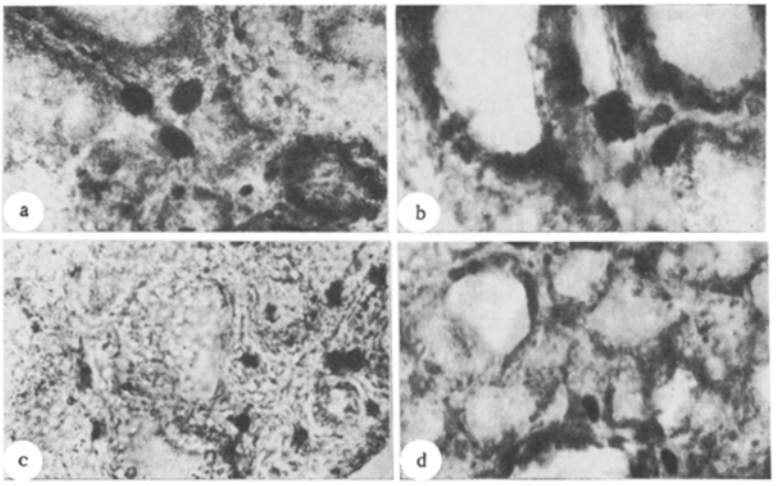

Fig. 2. Localization of mast cells and peroxidase reaction in the thyroid gland of rats at different times after burning: a) increase in peroxidase activity in epithelial cells of follicles and increase in size of mast cells 1 h after burning; b) degranulation of mast cells in interfollicular spaces 6 h after burning; c) decrease in number of mast cells and weak peroxidase activity of follicles in central zone of gland 24 h after burning; d) degranulation of mast cells and increase in peroxidase activity in the thyroid gland 72 h after burning. Stained by the method of Robertis and Grasso; a, c, d) 320 ×, b) 720 ×.

At different times of investigation after burning, a series of morphological and histochemical changes was observed in the pithelial cells of the thyroid gland of the experimental animals, including changes in peroxidase activity. Meanwhile changes in the localization and functional state of the mast cells also were observed, but the reaction for peroxidase in these cells remained strong nearly everywhere. For instance,

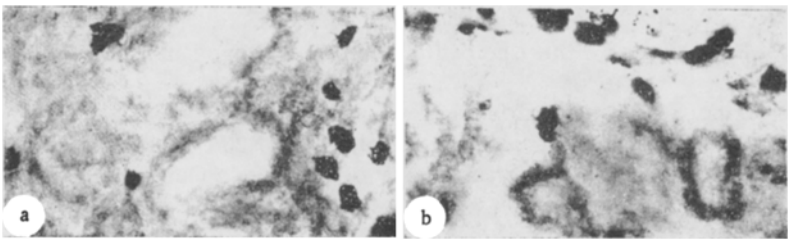

Fig. 3. Increased peroxidase activity in follicular cells and increased functional activity of mast cells in the thyroid gland of rats after burning and transfusion with homologous serum: a) 24 h, b) 72 h after burning. Stained by the method of Robertis and Grasso; 320 ×.

1 h after burning, the number of mast cells in the interfollicular spaces and their functional activity, expressed as granulation and partial degranulation of the cytoplasm, with well-marked metachromasia, were increased. In the epithelial cells of the follicles and in the mast cells at this period of the investigation, peroxidase activity was intensified (Fig. 2a). Peroxidase was concentrated 3 h after burning in the apical part of the epithelial cells of the follicles, and after 6-12 h a gradual decrease in the activity of the enzyme in the thyroid parenchyma was observed. Functional activity of the mast cells at all these times of investigation remained high. In the interfollicular spaces and, in particular, at the periphery of the gland the mast cells were enlarged (Fig. 2b) and were in the initial stage of degranulation. Throughout the thyroid parenchyma, 24 h after burning, a decrease in peroxidase activity was observed, mainly in the central zone of the gland. Mast cells in a stage of high functional activity were concentrated at the periphery of the gland, while in the central zone they were reduced in number and were located mainly in the connective-tissue stroma along the course of the vessels (Fig. 2c). The intensity of the reaction for peroxidase was increased 48 h after burning in the peripheral part of the thyroid gland, with an increase in the number and degree of degranulation of the mast cells in this zone of the gland. Peroxidase activity 72 h after burning was slightly increased in the epithelial cells of all the follicles, with an increase in the number of degranulated mast cells both under the capsule and in the interfollicular tissue (Fig. 2d).

The results thus indicate a definite relationship between functional activity of the mast cells of the thyroid gland and the intensity of the reaction for peroxidase in the epithelial cells of the thyroid parenchyma, for at nearly all periods of the investigation increased activity of the enzyme coincided with increased functional activity of the mast cells.

The same relationship has also been found during transfusion of burned animals with homologous serum, which stimulates thyroid function [1] and also causes an increase in the number of mast cells and in the degree of their degranulation [3].

For example, 24, 48, and 72 h after burning in animals receiving intravenous injections of serum in a dose of 0.5 ml/100 g body weight, peroxidase activity in the epithelial cells of the thyroid follicles was higher than in burned animals not receiving injections of serum. Activity of the enzyme was increased both at the periphery and in the central zone of the gland. At the same time, the number and degree of degranulation of the mast cells in the interfollicular tissue were increased throughout the thyroid parenchyma (Fig. 3a, b).

These results show that peroxidase activity in the tissue mast cells is high. However, the presence of this enzyme in the thyroid mast cells is evidently particularly important, for peroxidase participates in the specific process of thyroglobulin synthesis, and its activity and localization in the epithelial cells of the follicles are among the factors determining the oxidation-reduction potential of the thyroid parenchyma. This is also confirmed by results [11] indicating a connection between the morphology and number of the thyroid mast cells and the activity of the thyroid gland, and it reflects their important physiological role.

In experimental burns a definite parallel is thus observed between the localization, morphology, and functional state of the mast cells of the thyroid gland, with their high content of peroxidase, and the activity of this enzyme in the epithelial cells of the follicles. This suggests that the mast cells play a role in the transmission of peroxidase to the follicular cells of the thyroid gland.

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