CYTOLOGICAL ANALYSIS OF THE SECRETORY EPITHELIUM OF THE RAT SUBMANDIBULAR SALIVARY GLANDS HYPERTROPHIED AFTER REPEATED AMPUTATION OF THE LOWER INCISORS

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Repeated amputation of the lower incisors in August rats causes hypertrophy of the submandibular and sublingual salivary glands. Hypertrophy of the submandibular salivary glands is true in character and accompanied by hypertrophy of the structural components (acini, cells, nuclei). Hypertrophy of the cells is due to hypertrophy of the cell organelles and the accumulation of secretory masses in the cell. Hypertrophy of acinar cell nuclei is connected with polyploidization. Polyploidization and ultrastructural changes in the cells of the submandibular salivary gland are evidence of the increased functional activity of that organ.
KEY WORDS: *amputation of lower incisors; salivary glands; cytophotometry; DNA content.*

Mammalian salivary glands have weak powers of regeneration and do not show compensatory hypertrophy to loss of even a large proportion of the gland tissue [1]. Meanwhile the weight of the salivary glands can rise sharply under experimental conditions of various types and the hypertrophy in that case is true in character. One such experimental procedure is periodic amputation of the lower incisors in rodents [3-5]. This increase in weight of the submandibular salivary glands in rats is due to hypertrophy of the acini [3].

The cytological basis of these changes has been inadequately studied, and it was therefore decided to make the investigation described below.

EXPERIMENTAL METHOD

Experiments were carried out on 37 adult male August rats of the same age. Amputation of the lower incisors at the level of the gum margin was performed 6 times on the experimental animals. The submandibular salivary glands were investigated by light and electron microscopy, and by cytophotometric and morphometric methods (100 measurements on each animal in each method). Cytophotometric estimation of DNA was carried out in sections stained by the Feulgen method. The sections were examined in the SIM-1 scanning interference microscope, giving two characteristics: the area of the nuclei and their DNA content.

EXPERIMENTAL RESULTS

The weight of the submandibular complex after 6 amputations of the lower incisors was increased by 62% (the weight of the submandibular salivary glands was increased by 68% and the weight of the sublingual salivary gland by 31%).

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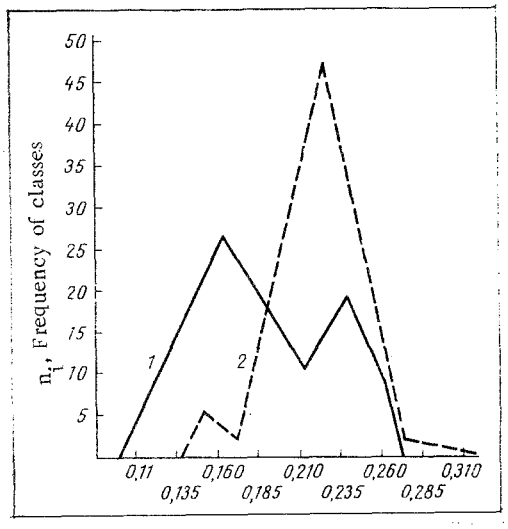

Fig. 1. Distribution curves of DNA concentration in section: 1) control; 2) experimental. Abscissa, DNA concentration (in conventional units); ordinate, number of nuclei (in %).

Comparison of the structure of the hypertrophied glands with that in the control animals showed marked hypertrophy of the acini. Visual observations were confirmed by the quantitative data obtained by morphometric methods.

The area of the acini in the experimental series was increased by 71%, the mean area of the acinar cells by 58%, and the area of the nuclei of the acinar cells by 88%. The mean number of nuclei per section through the acini was increased by 8%, indirect evidence of proliferation having taken place there, but no change in mitotic activity was observed. The DNA content in the nuclei of the acinar cells of the experimental animals was increased by 2.33 times. The distribution of nuclei by DNA concentration also was analyzed in the secion (i.e., by the ratio between the DNA content in the nucleus and the area of the given nucleus; Fig. 1). The curve of distribution of the DNA concentration in the section had two clearly defined peaks, the mean values of which were the same in both the control and the experimental series. However, whereas in the control the group of nuclei with the lower concentration (group 1) included 70% of the nuclei, in the experimental series these nuclei accounted for only 5-8% of the total number. More than 90% of the nuclei in the experimental series belonged to group 2 — the group with the higher DNA concentration.

It can tentatively be suggested that nuclei belonging to group 1 in their DNA concentration were evidently diploid, whereas nuclei with a higher DNA concentration (group 2) were tetraploid. In the control series the area of the group 2 nuclei was significantly greater than the area of the group 1 nuclei, and as a rule polyploidization is accompanied by an increase in size of the nuclei.

Analysis of the cytophotometric data thus suggests that under normal conditions 70% of nuclei are diploid and 30% belong to the tetraploid population. No active polyploidization was found in the experimental animals and the nuclei were mainly tetraploid.

Electron-microscopic study of the submandibular salivary glands after sixfold amputation of the lower incisors showed that hypertrophy was accompanied by intensification of function.

The following findings were evidence of the intensive synthetic reactions taking place in the acinar cells of the glands hypertrophied after six successive amputations of the lower incisors: 1) dilation of the cisterns of the granular endoplasmic recticulum compared with the control (Fig. 2); 2) fusion of secretory granules in the early stages of secretion formation, i.e., predominance of the diffuse path of elimination of secretion from the cells; distension of the cells with secretory masses (Fig. 3); 3) hypertrophy of the Golgi complex; 4) morphological changes in the mitochondria, local clearing of their matrix, interpreted by some workers as evidence of increased energy exchange between cytoplasm and mitochondria; 5) loosening of structure of nucleolus in the nuclei.

Evidence of hyperfunction also was seen in the cells of the granular portion. Hypertrophy of the Golgi complex, basal in its arrangement, was seen most clearly and distinctly in this region. Hypertrophy of the Golgi complex, its localization in the cell, and the filling of the basal part of the cells with secretory granules can be taken as evidence of increased liberation of secretion by these cells in the basal direction, i.e., intensification of the endocrine function of cells belonging to the granular portion.

Plasma cells were frequently found in the ultrathin sections. Their appearance possibly reflects the hypothetical participation of the immune system in the regulation of repair processes [2].

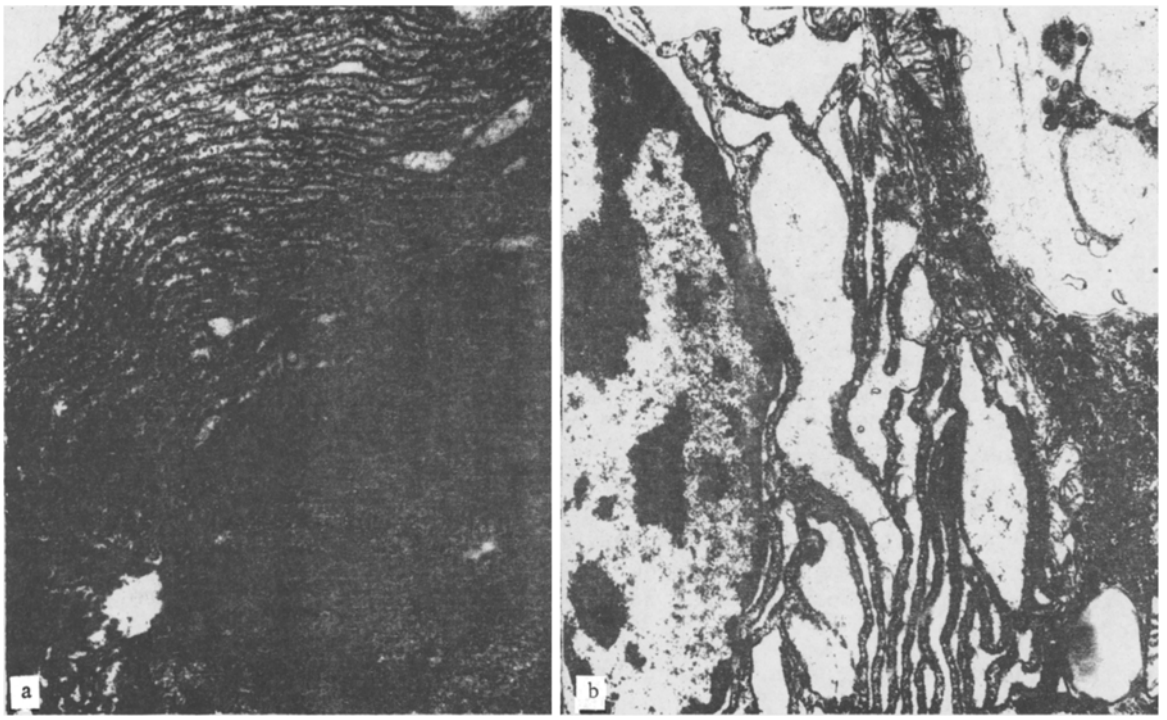

Fig. 2. Basal part of acinar cell: a) control, b) experimental; 24,000 ×.

Fig. 3. Fusion of secretory masses in acinar cells (13,000×).

Polyploidization and ultrastructural changes in the cells of the submandibular salivary glands are evidence of increased functional activity of the organ.

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