

pits of the glands, followed by widening of the zone of the precursor cells along the gastric glands, as far as the basal portions. These changes must be regarded as a protective and adaptive response to damage to the gastric epithelium by aspirin.

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FUNCTIONAL MORPHOLOGY OF THE SUBMAXILLARY SALIVARY GLANDS DURING AGE INVOLUTION IN ALBINO RATS

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UDC 612.673.13

A quantitative study was made of the morphological and functional characteristics of different parts of the submaxillary salivary glands of albino rats in different stages of involution of the neuroendocrine system. During aging the salivary gland function of rats is preserved, and just as in young animals, clear cyclic fluctuations are observed depending on the phases of the estrous cycle, although the basal level of proteins and mucopolysaccharides is reduced, to correspond on average to the minimal found in young animals. Meanwhile activation of the enzymes responsible for energy and transport processes in the cell is observed and relations between the enzymes are altered. The results prove that the salivary glands are connected with the endocrine system and they confirm the view that in early age involution what occurs is not so much a change of function as a disturbance of relations between the different indices of functional activity of the organ.

KEY WORDS: salivary glands; enzymes; involution; estrous cycle.

Age involution of the salivary glands is an interesting problem. This is because of the diversity of their function (the saliva contains enzymes responsible for starting the digestive process in the mouth, it has protective properties due to the presence of lysozyme and IgA [2]); there is also evidence of an internal secretory function of the salivary glands and of their connections with other endocrine glands, including the gonads [9].

There are as yet few data on age changes in the structural and histochemical indices of salivary gland function in animals of different species and in man. It has been shown that during age involution the type of secretion in all salivary glands varies, usually to the mucous type, giving greater protective properties [10, 14], many intercalated ducts are formed, and acid phosphatase and succinate dehydrogenase activity are reduced, whereas the number of terminal portions undergoing lipomatous changes is increased [15]. There is also evidence that with age proteolytic enzyme activity in the salivary glands of rats increases [1].

Department of Pathological Anatomy, I. P. Pavlov First Leningrad Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR V. K. Kulagin.) Translated from *Byulleten' Éksperimental'noi Biologii i Meditsiny*, Vol. 88, No. 12, pp. 736-739, December, 1979. Original article submitted October 16, 1978.

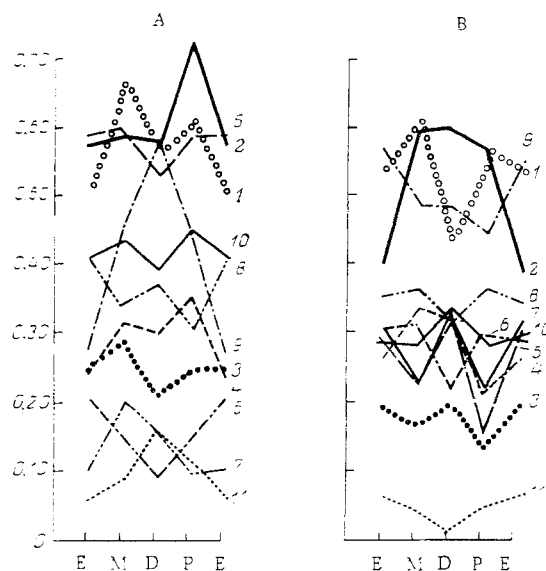


Fig. 1. Changes in enzyme activity and protein and mucopolysaccharide content in terminal portions of submaxillary salivary glands of albino rats during estrous cycle in young (A) and aging (B) animals. Here and in Figs. 2 and 3: 1) proteins; 2) PAS reaction; 3) NADP; 4) α -LAP; 5) IDH; 6) NAD; 7) MDH; 8) esterase; 9) AIP; 10) DNA; 11) RNA. Abscissa, phases of estrous cycle: E) estrus, M) metestrus; D) diestrus, P) proestrus; ordinate, optical density of reaction products (in relative units).

The object of the present investigation was to study the morphological and functional characteristics of the different portions, with their different functions, of the submaxillary salivary glands of albino rats at different stages of involutionary modification of the endocrine system.

EXPERIMENTAL METHOD

Experiments were carried out on 24 noninbred female albino rats aged 12-14 months and weighing 200-220 g. This period for rats is stated in the literature by some workers to be a period of maturity [3], but by others as a period characterized by features of involutionary modification of the neuroendocrine system [4, 6], with changes in the generative function (reduction in size of the liver) and an increase in the duration of the estrous cycle to 7-8 days because of lengthening of the diestrus phase. The phases of the estrous cycle were determined from the cytological picture of vaginal smears and the histological structure of the vaginal epithelium. The control consisted of 24 young rats aged 4-5 months and weighing 130-150 g. The material was obtained, stored, and investigated with all necessary precautions [5]. To assess the functional state of the salivary glands the combination of histochemical methods developed previously was used, followed by quantitative analysis of the data [8].

EXPERIMENTAL RESULTS

The study of the principal indices of secretory activity of the salivary glands and simple proteins and mucopolysaccharides in the terminal secretory portions showed that in aging animals, just as in young rats, fluctuations in the content of these substances depending on the phases of the estrous cycle were preserved. However, the amplitude of fluctuations in the mean indices was much greater, but the basal level of secretion was lower in all phases of the cycle and, in particular, in diestrus (Fig. 1). Two increases in the content of protein and mucopolysaccharides also were observed in aging animals, but whereas in young animals the highest peak occurred in the phase of proestrus, in the aging rats it was observed in metestrus. The mean indices of NAD-diaphorase and malate dehydrogenase (MDH) activity — enzymes determining the functional

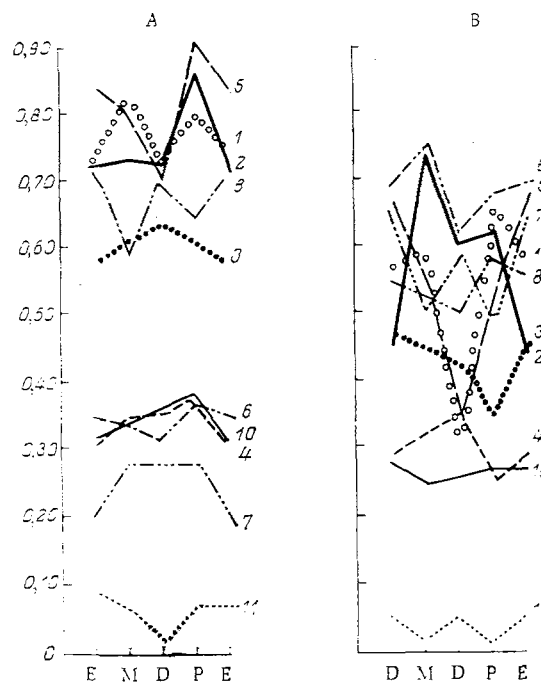


Fig. 2. Changes in enzyme activity and protein and mucopolysaccharide content in intercalated ducts of submaxillary salivary glands of albino rats during estrous cycle in young (A) and aging (B) animals.

state of the mitochondria — were higher than in young animals, but the amplitude of their fluctuations during the phases of the estrous cycle was maintained. Changes in the mucopolysaccharide and protein content in young animals were accompanied as a rule by synchronized fluctuations of NAD-diaphorase and MDH activity. These general principles did not hold good in the aging animals. For instance, a fall in the mucopolysaccharide and protein content in diestrus was accompanied in them by increased MDH activity and reduced NAD-diaphorase activity. As regards indices of intracellular synthesis — NADP-diaphorase and isocitrate dehydrogenase (IDH) activity — the former was practically unchanged in aging rats compared with young, whereas the latter was reduced almost by half. The increase in the indices of secretory activity of the terminal portions also was clearly inversely proportional to activity of nonspecific indices of intracellular synthesis. Similar relationships were found on analysis of activity of hydrolytic enzymes. A decrease in the mucopolysaccharide and protein content in the cells of the terminal secretory portions was accompanied by an increase in alkaline phosphatase (ALP) and α -leucine-aminopeptidase (α -LAP) activity. The results of the study of nucleic acids in the terminal portion of the submaxillary salivary glands of aging animals are evidence of a very small decrease in their content and of a change in the direction of the fluctuations, especially in diestrus.

More marked fluctuations in the mean values of the mucopolysaccharide and protein content also were found in the intercalated ducts of the submaxillary salivary glands of the aging rats than in young animals (Fig. 2). The maximal protein content was observed in estrus, whereas in the remaining phases of the estrous cycle there was a tendency for it to decrease. Changes in the activity of hydrolytic enzymes and dehydrogenases showed the same pattern as in the terminal secretory portions of the submaxillary salivary glands of the aging animals, but with more marked deviations (Fig. 2).

A considerable decrease in the protein and mucopolysaccharide content — by half compared with that in young animals — also was observed in the striated ducts of aging rats, especially in the diestrus phase (Fig. 3). NADP-diaphorase activity in these animals also was reduced compared with young rats, and the direction of the changes was opposite, with a tendency for the intensity of the reaction to diminish in diestrus and proestrus. The study of activity of hydrolytic enzymes showed that its changes were inversely proportional to fluctuations in the protein and mucopolysaccharide content in all phases of the estrous cycle. The content of nucleic acids, especially DNA, was reduced in the aging animals, as also was the amplitude of the fluctuations in all phases of the estrous cycle.

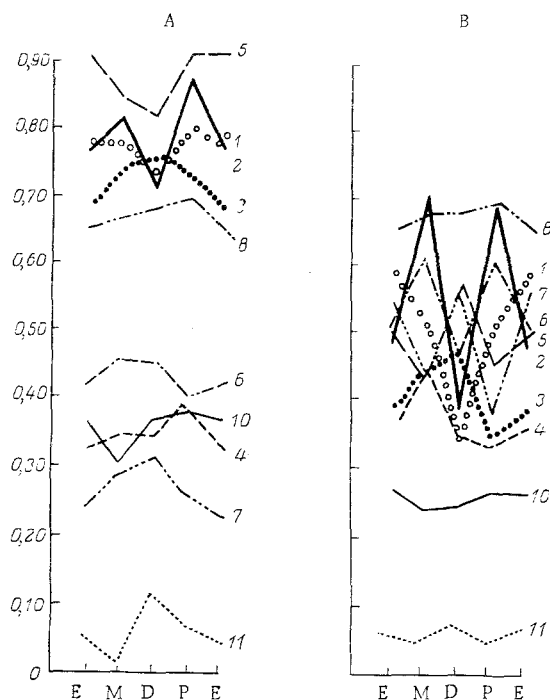


Fig. 3. Changes in enzyme activity and protein and mucopolysaccharide content in striated ducts of submaxillary salivary glands of albino rats during estrous cycle in young (A) and aging (B) animals.

In all parts of the submaxillary salivary glands of aging rats the basal level of proteins and mucopolysaccharides was thus reduced, and on average their content corresponded to the minimal level in young animals. Meanwhile activation of enzymes responsible for intracellular energy and transport processes was observed and the relations between them were changed. The range of cyclic fluctuations in the mean values of these indices was greater in the aging animals. These fluctuations were brought about by changes in the functional state of the majority of cells. A mosaic pattern of enzyme activation also was observed in the aging animals, but the focal distribution of the response was more marked with age.

Hence, in the stages of early age involution of the neuroendocrine system the function of the salivary gland in rats is preserved, cyclic fluctuations depending on the phases of the estrous cycle can be identified, but the indices of secretory function are depressed, especially in the intercalated and striated ducts which, according to data in the literature, are linked in rats with hormone synthesis [12, 13] and, more than any other portions, can change in response to readjustments in the endocrine system. The same relations are formed in the salivary glands as in the endocrine organs: during aging it is not so much function that is depressed as that relations between the different indices of functional activity of the organs are disturbed [6, 7]. It can be concluded from the results of these experiments that in the salivary glands of rats, before any true aging takes place and before marked structural changes have occurred, disturbances of metabolism arise and are manifested as changes in the basic indices of salivary gland function.

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