Effect of Ultrasound on Major Salivary Glands. Dynamic of Morphological Changes in Rat Salivary Glands

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Morphology of rat submandibular salivary glands was examined before and after 10 sessions of ultrasonic treatment focused onto the gonial angle of the mandibular bone. The employed ultrasound protocol induced adaptive reactions and induced no degenerative and inflammatory processes.

Key Words: *ultrasound stimulation; salivary glands; rat; mandibular bone*

Low- and high-intensity ultrasound (US) is applied in medicine. Low-intensity US (0.125-3.000 W/cm^2) is used to evoke non-damaging warming or nonthermal phenomena. It is also used for stimulation and acceleration of normal physiological reactions during treatment of damaged tissues. By contrast, high-intensity US (>5 W/cm^2) is employed to induce controlled and directed destruction of biological tissues [1,2,5,6].

High density of the compact lamina and cancellous matter of the bone tissue is a serious problem in orthodontology, which could be solved by increasing the plasticity of mandibular bone tissue with US irradiation [3]. However, US also acts on adjacent soft tissues including salivary glands (SG), whose normal function significantly affects the state of the organs in the oral cavity.

Our aim was to study the effect of US-irradiation of the lower jaw on the structure of glandular tissue in mandibular (submandibular and sublingual) SG.

MATERIALS AND METHODS

Experiments were carried out on laboratory albino rats under hexenal narcosis. The mandibular gonial region was shaved and subjected to US irradiation. The contact medium was mineral oil, the sonic transmitter area being 1 cm^2. The pulse mode sonication was performed at an intensity of 0.4 W/cm^2 for 10 min. Five, 10, and 20 days after the last (the tenth) sonication session, SG function was assessed quantitatively and qualitatively. Then, submandibular SG was isolated and fixed in 10% neutral formalin. Histological sections were prepared as described previously [4].

RESULTS

On post-sonication day 5, histological examination revealed no alterations in SG structure including all types and components of the excretory ducts and their terminal parts. The lumens of the major excretory ducts and salivary canals were widened and filled with mucous-protein fluid. Despite evident visual morphological integrity of SG structures, we observed significant widening of the excretory ducts with flattened and vacuolated epithelial cells filled with mucoid substance (Fig. 1). Secretory granules in the epithelial ducts were preserved, but the percent of cells with mucous increased. These changes can be explained by activation of the excretory function with predominance of mucous excretion. Secretory potency of acinar cells of the protein type and especially of the protein-mucous type increased, and this increase was accompanied by pro-

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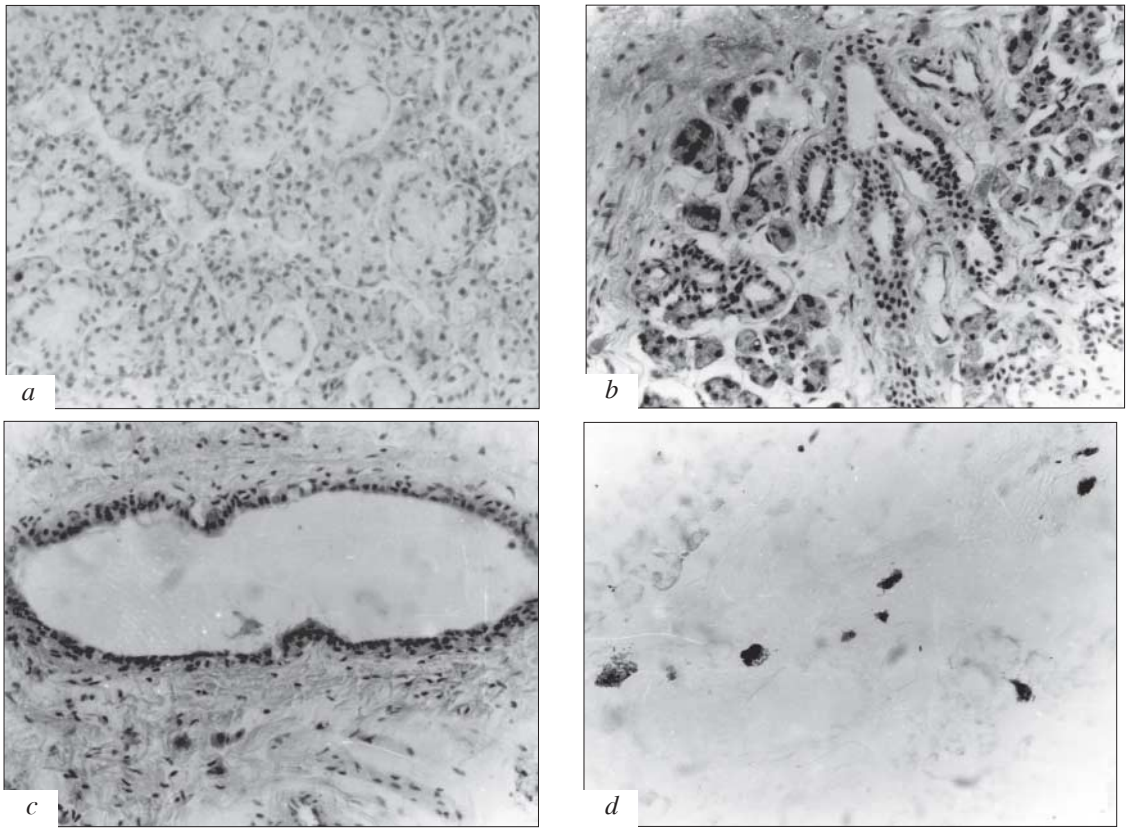

Fig. 1. Effect of US irradiation on rat submandibular SG. *a*) Compact arrangement of protein-mucous acinar cells in submandibular SG, ×220; *b*) pronounced widening of the excretory ducts and appearance of flattened and vacuolized epithelial cells on post-sonication day 5, ×200; c) mast cells with the signs of degranulation in the interlobular stroma of submandibular gland on post-sonication day 5, ×250; *d*) the same preparation at ×280. Hematoxylin and eosin (*a-c*) or Bismarck—Brown staining (*d*).

nounced transformation of the mucosa as revealed by mucicarmine. In the interstitial connective tissue, the structures of stromal components were intact, although accumulation of lymphocytic cells and macrophages was observed locally near small vessels. The number of mast cells markedly increased not only in the interlobular connective tissue, but also in the stroma of the interlobular vessels. Functionally active labrocytes were more numerous than degranulating cells. All these alterations affected the maintenance of the trophic potency of interstitial tissue.

Similar morphological picture was observed on post-sonication day 10. The mucous-protein acinar cells with elevated content of mucous secret still prevailed in the terminal parts of the excretory ducts, and they were clearly detected by mucicarmine. As before, the number of mast cells in the interlobular stroma and the degree of their degranulation were higher than in control animals; the excretory ducts with pyroninophilic mucous-protein secret were moderately widened (Fig. 2). The cells in the ductal walls contained more mucus-like substance than similar cells in the control rats. The number of hyperchromatic cells was elevated as before, which could indicate the regenerative potency not only of the acinar cells, but also of the cells in the striated ducts of submandibular SG.

On post-sonication day 20, the structure of experimental SG did not differ from the control.

Therefore, in delayed period after US treatment of the gonial angle of the mandibular bone, excretory activity was up-regulated not only in acinar, but also in ductal cells. However, the degree and quality of synthetic potency of the cells were modified as is seen from predomince of mucus-secreting cells over protein-secreting cells. These changes were probable related to secretion of mucous substance as a unspecific factors characterizing initial period of the adaptive reaction. Another relative index of this process is the increase in the number of labrocytes involved in elevation of myoepithelial cell tone and in cellular secretion. A certain elevation of excretory activity of SG epithelial cells was accompanied by activation of their physiological regeneration.

In conclusion, US treatment of mandibular SG induced adaptive changes not accompanied by signs of dystrophic or inflammatory processes. The data

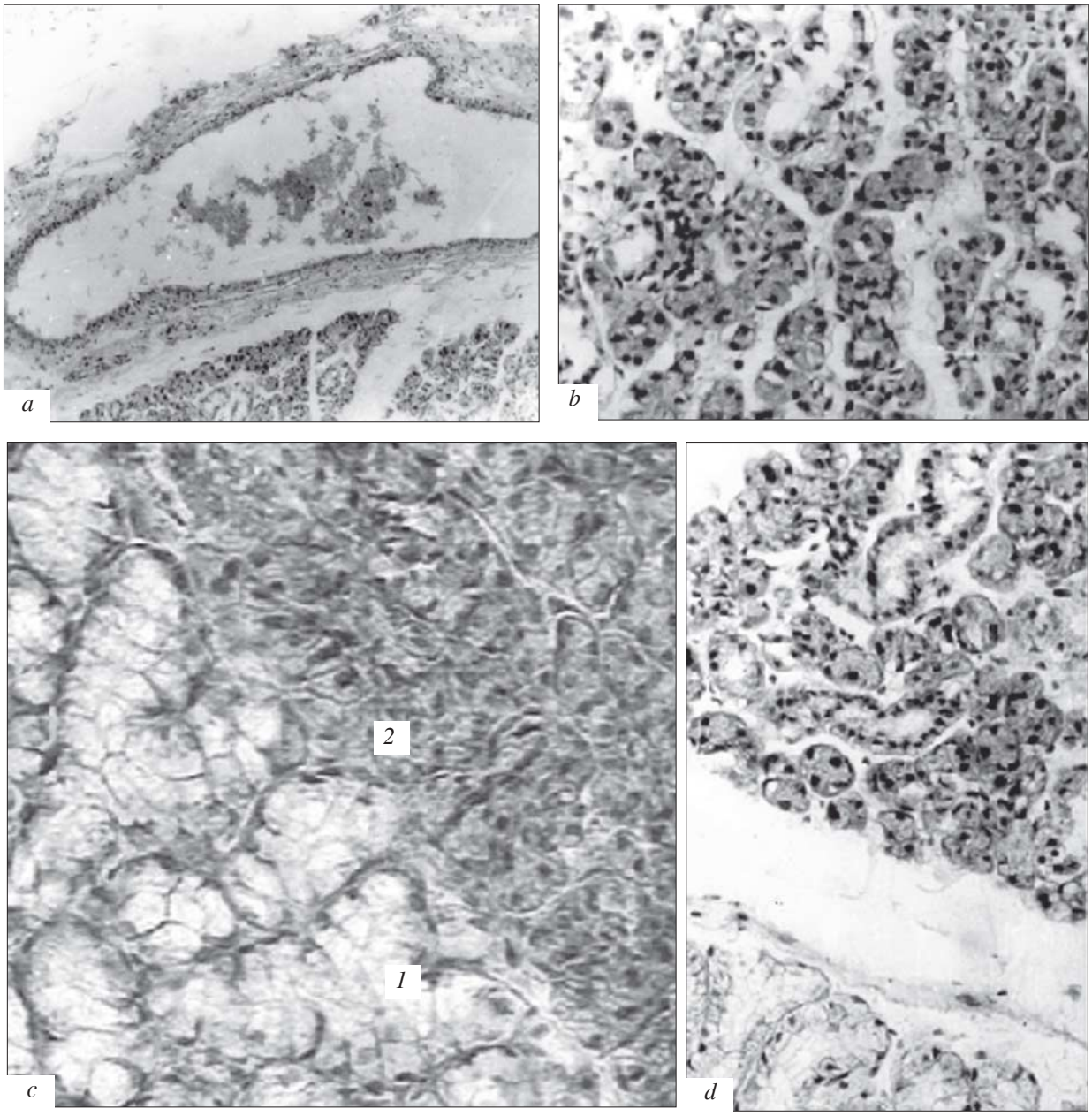

Fig. 2. Rat submandibular SG on post-sonication day 10. *a*) moderately widened excretory ducts with pyroninophile mucous-protein secreta (test for RNA), ×200; *b*) pronounced secretion of mucus-like substance with large vacuolation of the cytoplasm in protein parts of the terminal regions of excretory ducts as revealed by mucicarmine, ×250; c) borderline between sublingual (*1*) and submandibular (*2*) glands in the control: staining with hematoxylin and eosin, ×250; *d*) borderline between sublingual and submandibular glands after US treatment: elevated content of mucus-like substance in the terminal regions of excretory ducts, ×200. Hematoxylin and eosin staining.

suggest that in the delayed post-sonication period, the morphofunctional indices of SG completely returned to normal.

REFERENCES

1. V. B. Akopyan, *Ultrasound in Medicine* [in Russian], Moscow (1984).
2. A. di Dzhuzeppe and M. Santoli, *Vestn. Estetich. Med.,* **1**, No. 1, 8-24 (2002).
3. S. V. Ivashenko and A. G. Chaban, *Morphology of Rabbit Peripheral Blood under the Effect of Low-Frequency Ultrasound on Mandibular Bone Tissue* [in Russian], BGMU-Inform, BMZh 1, No 15 (2006).
4. B. Romeis, *Microscopic Technique* [Russian translation], Moscow (1954).
5. *Physics and Techniques of Powerful Ultrasound* [in Russian], Ed. L. D. Rozenberg Vol. 2, Moscow (1968).
6. I. E. El'piner, *Ultrasound: Physical, Chemical, and Biological Effects* [in Russian], Moscow (1963).