RESPONSE OF GANGLIA TO STRESS IN THE TERRITORY OF THE MAXILLODENTAL SYSTEM

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A neurohistological and histochemical investigation was made of the trigeminal and superior cervical sympathetic ganglia and also of the inferior ganglion of the vagus nerve of 35 dogs in whom four of the lower teeth were prepared for fitting with complete metal crowns. Polishing the hard tissues of the teeth was shown to induce reactive changes in some neurons, intraganglionic nerve fibers, and synaptic endings and in the content and distribution of RNA, glycogen, and hyaluronic acid in these ganglia on the side of preparation: The response was maximal 1-3 days after the operation. No marked changes were present in the ganglia 21-28 days after polishing of the teeth.

KEY WORDS: ganglia; preparation of the teeth; neurohistological changes.

Among the many different external environmental factors with a harmful effect on the human body, stress is one of the most important. It is noteworthy that in certain diagnostic and therapeutic procedures, reactions to stress may develop. For instance, the preparation of teeth such as is widely used in routine stomatologic practice is accompanied by a combination of stress-inducing factors: pain, injury to the tissues of the tooth, local hyperthermia, and negative emotions associated with the anticipation and conduct of the operation.

Although the neurohumoral mechanisms of reactions to stress have been investigated many times, the histomorphological basis of these reactions has been inadequately studied. It is therefore of great scientific and practical importance to study the effect of preparation of the teeth for crowning on the morphological state of the trigeminal and superior cervical sympathetic ganglia, the main ganglia innervating the face and oral cavity [2-5], and also the inferior ganglion of the vagus nerve. This last structure participates in the conduction of nociceptive sensation from the mouth [1].

EXPERIMENTAL METHOD

Experiments were carried out on 35 mongrel dogs aged from 10 months to 2 years. Four of the lower teeth were prepared for complete metal crowing in each dog by means of an electric drill with the abrasive bit rotating at 5000 rpm. While the hard tissues were being polished, the tooth was kept cool with water. The animals were killed by exsanguination through the femoral artery 1 h and 1, 3, 7, 14, 21, and 28 days after the operation. The ganglia to be studied were removed from the dogs and fixed in 10% neutral formalin solution or in Shabadash's fluid. Sections through the ganglia were stained with hematoxylin-eosin, by Van Gieson's and Nissl's methods, impregnated with silver nitrate by the methods of Bielschowsky and Gros and of Rasskazova, and also stained for RNA by Brachet's method, for glycogen by Shabadash's method, and for acid mucopolysaccharides by the methods of Steedman and Hale. For the enzyme-chemical control sections were incubated with bovine ribonuclease, amylase, and bacterial hyaluronidase. The number of changed nerve cells was counted in three central sections through all the ganglia impregnated with silver. The numerical data were subjected to statistical analysis by Student's t-test.

EXPERIMENTAL RESULTS

A decrease in the density of basophilic material in the perikaryon of some of the medium-

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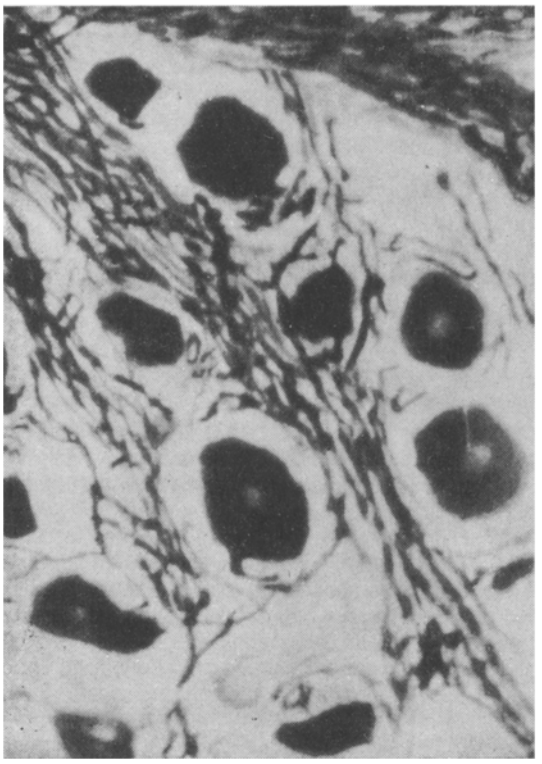

Fig. 1

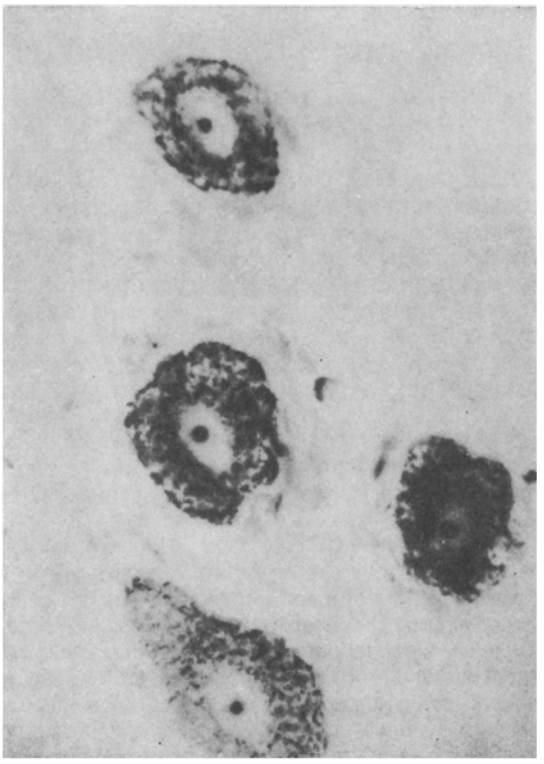

Fig. 2

Fig. 1. Irregularity of outlines, hyperargentophilia, and varicose expansions in processes of neurons and nerve fibers of trigeminal nerve ganglion. Impregnation with silver by Bielschowsky–Gros method, 400×.

Fig. 2. Pulverization and lysis of basophilic material in cytoplasm of nerve cells of inferior ganglion of vagus nerve. Nissl's method, 400×.

sized and large nerve cells of the trigeminal never ganglion and the inferior ganglion of the vagus nerve, and concentration of basophilic material in the peripheral zone of the cytoplasm were observed on the side of preparation 1 h after abrasion of the hard tissues of the teeth. In the small cells hyperchromatosis of the Nissl's substance predominated. Processes of the neurons and axis cylinders of the thick myelinated intraganglionic nerve fibers were characterized by irregularity of their outlines, excessive argentophilia, and hyperargentophilic varicose expansions of circular or oval shape (Fig. 1). Nerve cells whose thickened processes twisted in corkscrew fashion and formed whorls, loops, and turns, could be seen sometimes in the inferior ganglion of the vagus nerve, whilst in the trigeminal ganglion they occupied whole fields of vision. Hyperchromatosis of the basophilic substance and thickening and increased argentophilia of the intra- and extracellular neurofibrils were clearly visible in the small and medium-sized neurons of the superior cervical ganglion. Some synaptic boutons and loops were hypertrophied and hyperimpregnated.

Most neurons in the ganglia of the experimental animals had red RNA granules scattered diffusely and uniformly throughout the cytoplasm or concentrated near the karyolemma and cytolemma. The number of small reddish-violet glycogen granules was increased in the cytoplasm of many nerve cells. The content of hyaluronic acid was unchanged.

The changes detected previously in neurons of the trigeminal and inferior vagus ganglia 1-3 days after preparation of the teeth were frequently combined with pulverization or lysis of the basophilic material in the central zone of the cytoplasm, hypertrophy and an eccentric position of the nucleus, and hyperchromatosis and displacement of the nucleolus toward the karyolemma (Fig. 2). The intracellular neurofibrils in this same zone of the cytoplasm were thickened and impregnated intensively with silver, and sometimes their orientation was disturbed. Boutons and pinhead or spherical thickenings were found on the ends of the processes of single neurons. Hyperplasia and proliferation of the satellite cells surrounding modified nerve cells as a single or double dense ring were observed.

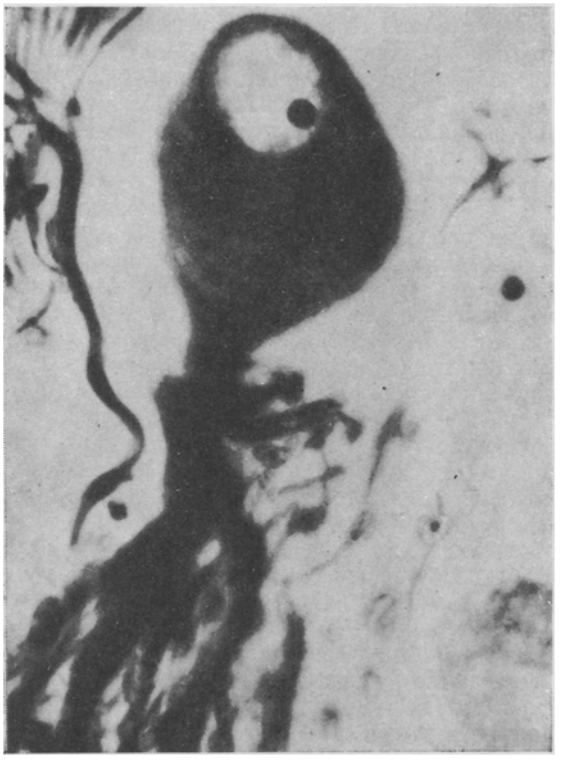

Fig. 3. Ectopia of nucleus and nucleolus, irregularity of outlines, and varicose expansions in processes of neuron from superior cervical sympathetic ganglion. Impregnation with silver by Bielschowsky–Gros method, 400×.

In many neurons of the superior cervical ganglion central chromatolysis could be seen, with the nucleus shifted sharply to the side opposite the origin of the axon. The rim of the round synaptic loops was thickened and their lumen narrowed. Tortuosity, irregularity of outlines, hyperargentophilia, and very small argentophilic varicose thickenings appeared in the processes and axis cylinders of unmyelinated intraganglionic nerve fibers, and massive pools of axoplasm could be seen in the large-caliber myelinated nerve fibers (Fig. 3).

The cytoplasm of the neurons and satellite cells of the ganglia studied contained not only bright red granules, but also large clumps of RNA. The number of neurons with perinuclear and peripheral concentrations of reddish-violet glycogen granules was increased. The nuclear membrane of the large nerve cells and the walls of the blood vessels and fibrous structures of the stroma were strongly PAS-positive.

Slight accumulation of hyaluronic acid was observed in the cytoplasm of the large and medium-sized neurons, in the form of pale, diffuse staining or of tiny granules.

The number of modified neurons in the gasserian ganglion was 1.7 times greater than in the superior cervical ganglion and 1.2 times greater than in the inferior ganglion of the vagus nerve. The difference between the numbers of modified nerve cells in the ganglia of the experimental and control dogs was statistically significant ($P<0.001$).

The signs of irritation in the ganglia 7-14 days after the operation were moderate in character. The number of large and medium-sized neurons with nucleus and nucleolus of the usual size and location, granules of basophilic material, and the normal caliber and structure of their processes was increased. The thin neurofibrils wound around the nucleus formed a dense plexus. A decrease in the intensity of pyroninophilia and of the reaction for neutral and acid mucopolysaccharides was observed in the nerve cells.

The ganglion cells 21-28 days after preparation of the teeth had the normal neurohistological structure except for a few small neurons which showed central chromatolysis and decentralization of the nucleus. Most of the intraganglionic nerve fibers were of uniform

thickness and had distinct outlines. The content and distribution of RNA, glycogen, and hyaluronic acid in the nerve cells was normal again.

Differences between the numbers of changed neurons in the ganglia of the experimental and control animals were not statistically significant ($P>0.5$).

Preparation of the teeth for crowning thus induces reversible changes in some neurons, intraganglionic nerve fibers, and synaptic endings in the trigeminal and superior cervical sympathetic ganglia and the inferior ganglion of the vagus nerve on the side of the operation. The nerve cells of the gasserian ganglion undergo more varied and intensive changes. This can evidently be explained by its anatomical and physiological features and by the velocity and level of flow of afferent impulses. The relative resistance of unmyelinated nerve fibers compared with myelinated was observed and may perhaps be due to differences in the velocity of conduction of nociceptive impulses in them. The results of the investigation demonstrate the high plasticity and functional adaptability of these ganglia and they can serve as original data for the experimental evaluation of the effectiveness of existing methods of anesthesia in orthopedic stomatology and methods in process of development.

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ELECTRON-HISTOCHEMICAL STUDY OF THE LOCALIZATION OF ADENYLATE CYCLASE AND ACETYLCHOLINESTERASE IN SYNAPSES OF THE CORTEX AND BASAL GANGLIA OF THE RAT BRAIN

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Synapses of the cerebral cortex and basal ganglia of rats were studied by electron-histochemical reactions for adenylate cyclase and acetylcholinesterase. On the basis of the characteristics of the presynaptic terminal vesicles and the localization of the two enzymes in the synapse receptor area three types of synapses were identified; cholinergic, adrenergic, and mixed.

KEY WORDS: types of synapses; adenylate cyclase; acetylcholinesterase.

During analysis of the cytopharmacological effect of neurotropic agents changes in the synapses play the leading role [2, 4]. The division of synapses into cholinergic and adrenergic [1, 4], adopted in modern enurobiology, is based on biochemical and pharmacological data and takes account mainly of the neuromediator present in the presynaptic terminal.

The object of the present investigation was to develop a cytochemical model of a central synapse on the basis of the results of detection of adenylate cyclase (model of an adrenergic receptor) [5] and acetylcholinesterase (model of a cholinergic receptor) [3]. The results were generalized with allowance for both the receptor discovered and the neurotransmitter contained in the vesicles of the presynaptic terminal.

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