SECRETORY REACTIONS OF THE SALIVARY GLANDS DURING STIMULATION OF THE HYPOTHALAMUS IN RELATION TO THE FREQUENCY, STRENGTH, AND DURATION OF STIMULATION

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Translated from Byulleten' Eksperimental'noi Biologii i Meditsiny, Vol. 57, No. 2, pp. 16-20, February, 1964

Original article submitted January 19, 1963

The character of the influence of the hypothalamus on the secretion of saliva in normal conditions and after frontal lobectomy and the paths of transmission of these influences on the secretory activity of the salivary glands have been studied previously [3, 4, 6]. In these investigations we stimulated various parts of the hypothalamus with an electric current of optimal frequency and minimal strength. An alternating sinusoidal current and a stream of rectangular pulses were used. Since the strength, frequency, and duration of the current, and also its other characteristics have a significant bearing on the reactions of the digestive apparatus to stimulation of the hypothalamus, it was necessary to study how the salivary glands would react to stimulation of the hypothalamus with a sinusoidal current and a stream of rectangular pulses differing in frequency and strength. These problems are important, not only for the technical aspect of the investigations, but also to elucidate certain properties of the structures of the hypothalamus and their sensitivity to electric currents possessing different characteristics.

The present paper describes the results of a study of the secretory reactions of the salivary glands during stimulation of the hypothalamus by a stream of rectangular pulses and a sinusoidal current, and their dependence on the frequency, the strength, and the duration of action of the stimulating current.

EXPERIMENTAL METHOD

Investigations were made in the course of a chronic experiment on 9 dogs in which the common ducts of the mixed salivary glands were exteriorized by the Pavlov-Glinskii method and multipolar electrodes implanted into the hypothalamic region.

The technique of implantation of electrodes into the hypothalamic region was described in previous papers [1, 2]. The essence of it is that multipolar electrodes, mounted in a thin horseshoe-shaped plate made of plexiglass or thin motion picture film (after removal of the emulsion), are applied to the hypothalamic region around the pedicle of the hypophysis (anteriorly or posteriorly to it) through a burr hole in the temporal bone. The plexiglass block with the pins for connecting the stimulating current was fixed to the frontal bone by means of a specially constructed attachment. The investigations were carried out on dogs with 4- and 6-pole electrodes implanted into the various parts of the hypothalamic region. The position of the electrodes was verified after the operation roentgenographically and macroscopically in sections of the hypothalamus.

The various parts of the hypothalamus were stimulated for 3-5 min by an electric current from a stimulator generating rectangular pulses with frequencies of between 6 and 300 pulses/sec (duration of pulse 0.2 millisecond, voltage 0.7-0.8 V) or with a sinusoidal current from a type ZG-10 audiofrequency generator, with frequencies of between 20 and 200 cps and a strength of between 0.1 and 1 mA. Bipolar and unipolar stimulation of the hypothalamus were used.

The saliva secreted during definite time intervals (1, 3, and 5 min) by the mixed salivary glands during and after stimulation of the hypothalamus was collected in separate portions. The volume of saliva was measured and its refractive index and content of solid residue and of organic and inorganic matter determined. The refractive
During stimulation of the hypothalamus with a sinusoidal electric current and with a stream of rectangular pulses caused salivation, which ceased after stimulation was discontinued. The volume of saliva secreted in these conditions and the rate of secretion varied with the part of the hypothalamus stimulated. The greatest intensity of salivation was observed during stimulation of the anterior and middle parts of the hypothalamus. During stimulation of the posterior part of the hypothalamus much less saliva was secreted. The percentage of solid residue and of organic matter and also the refractive index increased in most experiments with an increase in the intensity of salivation. No significant change took place in the concentration of inorganic substances under these circumstances.

Unipolar and bipolar stimulation of one side (right or left) of the hypothalamus caused greater salivation from the gland situated on the ipsilateral side. Stimulation of the side of the hypothalamus opposite to the gland caused secretion of a much smaller volume of saliva or had no effect on secretion, thus confirming our previous findings.

To explain the differences between the stimulating action of the sinusoidal current and the stream of rectangular pulses on the structures of the hypothalamus, experiments were conducted in which prolonged stimulation was applied to the same part of the hypothalamus. Prolonged stimulation of the middle parts of the hypothalamus with a stream of rectangular pulses caused the secretion of saliva throughout the period of its action, and the volume of saliva secreted during each minute remained at a high level. Small amounts of saliva continued to be secreted for some time after the cessation of prolonged stimulation. The results of an experiment conducted on the dog Tikhii are shown in Fig. 1. During stimulation of the middle part of the hypothalamus with a stream of rectangular pulses for 12 min, intensive secretion of saliva took place, and this was maintained at a high level throughout the period of stimulation. In 1 min approximately 1 ml of saliva was secreted, and 13 ml during the whole period of stimulation (12 min). After stimulation was discontinued the secretion of saliva continued for a further 2 min.

Prolonged stimulation of the same part of the hypothalamus with the sinusoidal current had a rather different effect on the function of the mixed salivary glands. It will be clear from Fig. 2 that during stimulation of the hypo-