ELECTRICAL ACTIVITY OF STRIATED MUSCLES OF THE CERVICAL PART OF THE RABBIT ESOPHAGUS DURING HUNGER, FEEDING, AND SATIATION

A. A. Kromin

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Recent investigations have shown that during hunger development many brain neurons exhibit irregular, burstlike spike activity, which becomes regular in character when the food need is satisfied [4, 5]. However, the characteristics of electrical activity of the peripheral contractile elements of the digestive tract and, in particular, of the esophageal striated muscles, during hunger, feeding, and satiation, have so far received little study, because most electromyographic investigations of the esophagus have been conducted under acute experimental conditions [7, 8, 10, 13]. The aim of the present investigation was accordingly to study the discharge activity of motor units (MU) of the cervical part of the esophagus during hunger, feeding, and satiation.

EXPERIMENTAL METHOD

Experiments were carried out on 12 male chinchilla rabbits weighing 2-3 kg, on which bipolar silver electrodes were implanted beforehand into the muscular coat of the cervical part of the esophagus. In six animals a miniature tungsten electrode also was implanted into the masseter muscle. Electrical activity of the esophageal muscles and masseter was recorded after deprivation of food for 24 h, during feeding, and in the stage of sensory satiation [1], in a chronic experiment using the technique described previously [2, 3]. Distributions of interspike intervals were investigated. The discharge activity of MU during the act of eating also was subjected to statistical analysis, with determination of temporal parameters of bursts of action potentials, intervals between bursts, and periods of burstlike activity.

EXPERIMENTAL RESULTS

The experiments showed that electrical activity of striated muscles of the proximal zone of the cervical part of the esophagus in hungry animals is characterized by an aperiodic, low-amplitude (0.1-0.2 mV), regular discharge activity of MU (Fig. 1), reflected on the histogram of stochastic distribution of interspike intervals as a monomodal distribution with a maximum in the 50-100 msec region (Fig. 2). This is confirmed also by low values of the coefficient of variation (22%). The mean duration of interspike intervals was 78 ± 1.7 msec. Action potentials were grouped sporadically in rhythm with respiration (Fig. 1). Muscles located 10-20 mm distally to the cranial end of the esophagus also exhibited aperiodic regular spike activity, characterized by a lower frequency ($p < 0.001$) and independent of the discharge activity of MU of the proximal zone (Fig. 1). These data are evidence of tonic activation of muscles of the proximal part of the cervical part of the esophagus. Meanwhile, in its distal part, spike activity of MU could not be detected. During orienting-investigative and searching activity by the animals, tonic activity of muscles of the proximal end of the esophagus was increased, as shown by quickening of discharge activity ($p < 0.001$) and mobilization of high-threshold MU (Fig. 1), giving rise to increased muscle tone.

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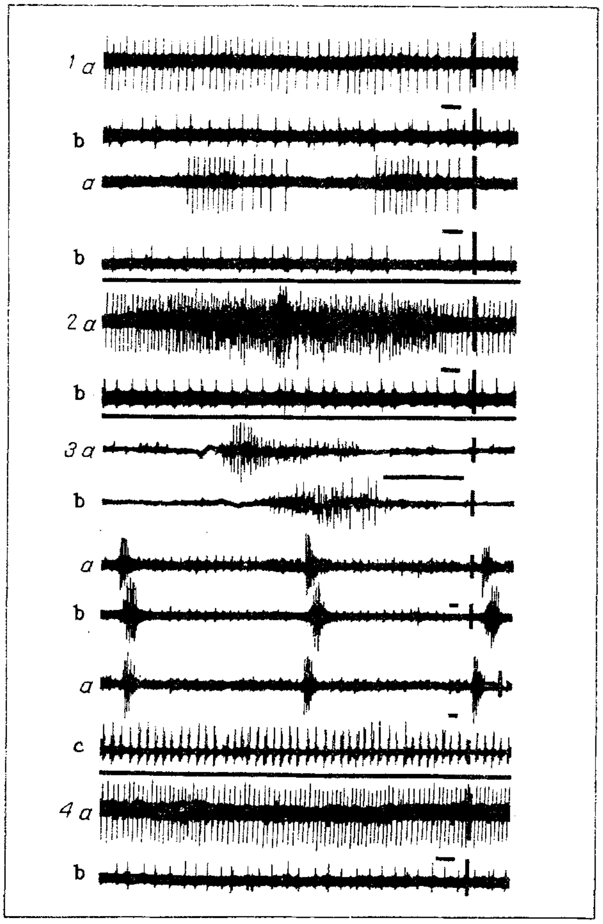

Fig. 1. Electrical activity of muscles of cervical part of rabbit esophagus during hunger, feeding, and satiation. 1) In hungry animals in the absence of locomotion, 2) during orienting-investigative activity, 3) during feeding, 4) in stage of sensory satiation, a) electrical activity of muscles of proximal zone of cervical part of esophagus, b) discharge activity of MU in region 15 mm distally to cranial end of esophagus, c) spike activity of MU of masseter muscle; time marker 200 msec, calibration signal: in 1, 2, and 4) 0.2 mV, in 3) 1 mV.

During feeding spike activity of the muscles of the cranial end of the esophagus changed its pattern and became burstlike in character, with mobilization of high-threshold MU (Fig. 1), as shown by the bimodal distribution of interspike intervals with maxima in the regions of 10-25 and 4400-5000 msec (Fig. 2) and by the high values of the coefficient of variation (456%). Generation of bursts of action potentials was preceded by periods of inhibition of electrical activity (172 ± 1.8 msec), corresponding to relaxation of the sphincter (Fig. 1). In the distal zone of the cervical part of the esophagus only generation of burst of action potentials was observed (Fig. 1). A high degree of regularity of burstlike activity and, consequently, of contractile activity of the esophagus was discovered, and was reflected in the histogram by a monomodal distribution (Fig. 3). The duration of the bursts of action potentials and of intervals between the bursts also had low variability (Fig. 3). Moreover, during feeding the esophageal MU regularly generated low-amplitude bursts of action potentials in the rhythm of chewing (Fig. 1), evidence of synaptic interactions between neurons of the chewing and swallowing centers. In the stage of sensory satiation electrical activity of muscles of the cranial end of the esophagus was characterized by regular low-amplitude discharge activity of MU (Figs. 1 and 2), with a higher frequency than during hunger ($p < 0.001$).

The results are evidence of tonic activation of muscles of the proximal part of the cervical part of the esophagus outside digestion, and this is characteristic also of discharge activity of MU of the cricopharyngeal muscle, which performs the function of the upper esophageal sphincter [8-12, 14]. In this connection several workers have obtained experimental confirmation of the involvement of muscles of the cranial end of the esophagus in the sphincter mechanism. During feeding the esophageal MU ex-

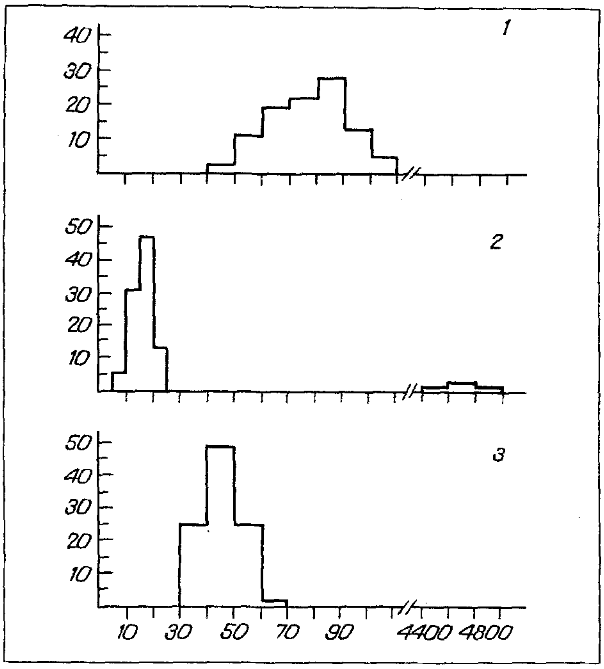

Fig. 2. Histograms of stochastic distribution of values of interspike intervals during discharge activity of MU of muscles in proximal end of esophagus during hunger (1), feeding (2), and stage of sensory satiation (3). Abscissa, time (in msec); ordinate, probability of interspike intervals (in %).

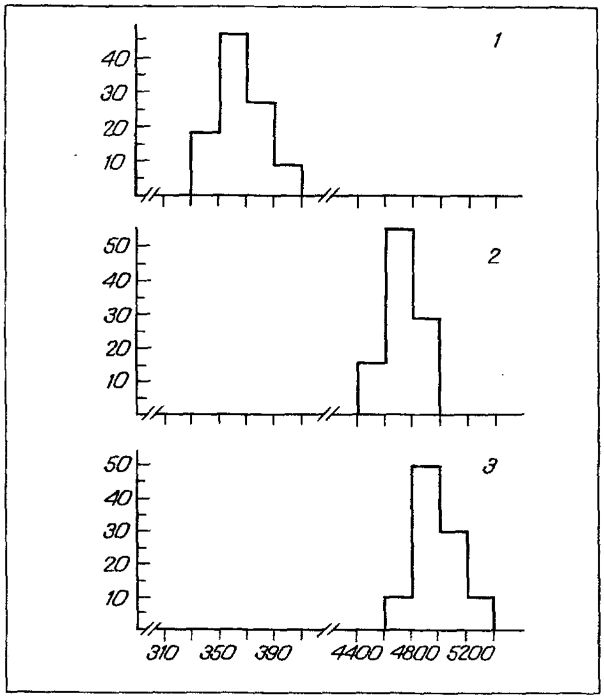

Fig. 3. Histograms of stochastic distribution of duration of bursts of action potentials (1), intervals between bursts (2), and periods of burstlike discharge of action potentials (3), recorded from muscles of proximal zone of cervical part of esophagus during feeding. Abscissa, time (in msec); ordinate, probability of time intervals (in %).

hibit burstlike spike activity [6, 13, 14], which is reflected in characteristic patterns of distribution of interspike intervals. The high degree of regularity of the burstlike spike discharge determines the regular character of peristaltic contractions of the esophagus.

Reorganization of the spike activity of MU of the esophageal muscles during the satisfaction by animals of their demand for food is thus manifested by characteristic patterns of distribution of interspike intervals.

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