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EFFECT OF FEEDING ON ELECTRICAL ACTIVITY OF THE DUODENAL SMOOTH MUSCLES IN DOGS

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Electrical activity of the duodenal smooth muscles was studied with the aid of permanently implanted electrodes. This activity was compared in the fasting state and at a time after feeding equal to the duration of the resting period and the period of activity of the duodenum outside digestion. Duodenal activity after feeding, as reflected in the number of pace-setting potentials, corresponded to its fasting activity. Duodenal activity during digestion differed considerably as regards the number of spike volleys outside digestion. The ratio between "digestive" and "fasting" duodenal electrical activity depended on the type of potentials and the periods of time compared. The optimal nature of "digestive" activity of the duodenal smooth muscles is evidently reflected in the fact that this activity fluctuates within certain limits during digestion: between maximal activity during the period of work and minimal activity during the period of rest outside digestion.

KEY WORDS: duodenum; electrical activity before and after feeding.

Electrical activity of the smooth muscles of the gastrointestinal tract takes the form of pace-setting and spike potentials. The pace-setting potentials (slow electrical waves) determine the highest possible frequency of contractions of the smooth muscles. Spike potentials, i.e., action potentials (AP), are connected with the presence of these contractions [6-9]. The ratio between the number of volleys of AP and the number of pace-setting potentials (the percentage of spike activity) is one of the most informative indices of the motor function of the gastrointestinal tract. However, information on the value of this index for the duodenum during its periodic activity and during digestion is limited in amount and contradictory in nature [7-11].

The object of this investigation was to study the effect of feeding on electrical activity of the duodenal smooth muscles in dogs, allowing for periodic fluctuation of this activity outside digestion.

EXPERIMENTAL METHOD

Experiments were carried out on four dogs weighing 20-28 kg. Silver loop electrodes were implanted into the smooth-muscle layer of the middle third of the duodenum (interelectrode distance 5-10 mm). The plug and socket unit for the electrodes was fixed subcutaneously on the anterior abdominal wall. The derived potentials were recorded on encephalograph. Experiments began 10-14 days after implantation of the electrodes. Each experiment started 16-18 h after feeding and was repeated once or twice a week for one or two months. Six experiments were performed on each animal. At least one periodic cycle of duodenal activity was recorded in the fasting state. The animals were fed differently in the course of the ex-

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TABLE 1. Comparative Characteristics of Electrical Activity of Duodenal Smooth Muscles in Fasting Dogs and after Feeding for Equal Time Intervals (M ± m; n = 6)

Dog number	Duodenal activity during time equal to resting period				Duration of resting period, min	Duodenal activity during time equal to duration of working period				Duration of resting period, min
	outside digestion		during digestion			outside digestion		during digestion		
	number of pace-setting potentials	number of volleys of AP	number of pace-setting potentials	number of volleys of AP		number of pace-setting potentials	number of volleys of AP	number of pace-setting potentials	number of volleys of AP	
1	941±179	12±12	901±168	240±68	48±9	560±169	329±77	563±178	130±48	29±9
2	989±195	4±1	976±145	271±97	53±10	434±61	260±52	439±59	104±33	23±3
3	1299±234	23±17	1293±268	245±97	70±13	554±79	283±18	554±63	149±52	30±4
4	928±96	28±22	937±97	378±37	53±6	410±58	314±48	406±56	177±47	23±3

periments: dog No. 1 received 100 g bread and 200 g tea, No. 2 received 300 g meat, and No. 3 received 300 g milk. Dog No. 4 received an ordinary mixed diet (soup + 300 g meat) during the experiments and ate 0.8-1.5 kg. In all the experiments feeding took place at the beginning of the resting period of the duodenum. Duodenal electrical activity was recorded for equal times before and after feeding.

The following parameters of duodenal myoelectrical activity were analyzed: the duration of the periods of rest and periods of work, the number of pace-setting potentials, the number of volleys of AP and the percentage of spike activity during the periods of fasting and also during the same time intervals after feeding that were analyzed. The statistical significance of differences between the means was determined from the degree of their variation [2].

EXPERIMENTAL RESULTS

Electrical activity of the duodenal smooth muscles after feeding was irregular compared with the regular alternation of periods of rest and periods of work outside digestion. The "digestive" and "fasting" activity of the duodenum was therefore compared during the period of rest and the period of work, and also during the analogous time interval after feeding, i.e., during each comparison the period of duodenal activity during digestion corresponded to a similar period outside digestion.

It will be clear from Table 1 that the number of pace-setting potentials appearing in the duodenal electromyograms during the time equal to the duration of the resting period after feeding was almost the same as during the resting period outside digestion in all the animals. The same ratio between the number of pace-setting potentials in the fasting state and after feeding also was observed when they were compared over a period equal to the duration of the period of work of the duodenum.

Meanwhile, to judge from the number of volleys of AP, electrical activity of the duodenal smooth muscles after feeding differed considerably from their activity in the fasting state. For instance, comparison of duodenal activity for a period equal to the duration of the resting period showed that the number of volleys of AP during digestion was considerably greater than their number outside digestion. Comparison over a period equal to the duration of the work period, however, showed that the number of volleys of AP during digestion was reduced by almost half compared with their number outside digestion. With both types of comparison (whether for the duration of the resting period or for the duration of the working period), moreover, the differences between "digestive" and "fasting" duodenal activity was statistically significant.

To judge from the number of pace-setting potentials, electrical activity of the duodenal smooth muscles after feeding thus corresponded to their activity outside digestion, whereas judging from the number of volleys of AP, these types of normal physiological activity of the duodenum ("fasting" and "digestive") differed considerably from each other in all animals.

Consequently, the ratio between "fasting" and "digestive" myoelectrical activity of the duodenum depends on the type of potentials compared and also on the period of time during which such a comparison was made.

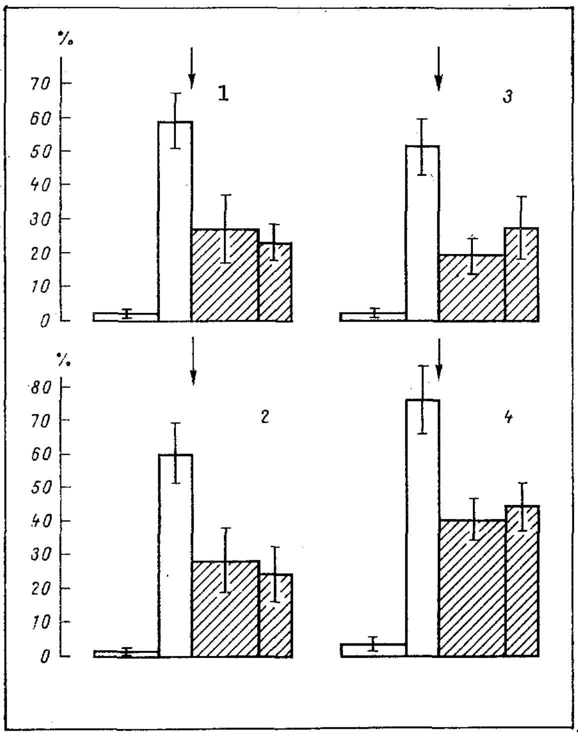

Fig. 1. Ratio between percentage of spike activity of duodenal smooth muscles of fasting dogs and after feeding for equal time intervals. 1,2,3,4) Nos. of animals. Wide columns denote activity for time equal to duration of resting period, narrow columns show activity for time equal to duration of working period. Arrows indicate times of feeding. Shaded columns indicate activity after feeding. Ordinate, percentage of spike activity of duodenal smooth muscles of dogs (number of volleys of AP as a percentage of number of pace-setting potentials per unit time).

This last dependence also was reliably confirmed by data for the percentage of spike activity, i.e., the ratio between the number of volleys of AP and the number of pace-setting potentials. The percentage of spike activity after feeding, when compared for a time equal to the duration of the resting period, was considerably higher than in the fasting state. Conversely, when these types of activity were compared for a time equal to the duration of the working period, the percentage of spike activity during digestion was considerably lower than outside digestion (Fig. 1).

Outside digestion the percentage of spike activity, calculated for the period of work, differed considerably from this index when calculated for the period of rest. Meanwhile, during digestion the percentage of spike activity calculated for a time equal to the duration of the working period for each of the types of feeding offered to the dogs, i.e., in each individual animal, did not differ significantly from this index calculated for the time of rest.

The percentage of spike activity of the duodenal smooth muscles after any type of feeding was thus considerably higher, on the one hand, than in the period of rest while in the fasting state, and, on the other hand, considerably lower than in the period of work outside digestion.

Consequently, the ratio between "digestive" and "fasting" activity of the duodenum, to judge from the percentage of spike activity, depends on the periods of time compared.

The uniformity of the responses of the duodenal smooth muscles to different types of feeding compared with their "fasting" activity, together with data in the literature [1, 3, 4-6, 12, 13] showing that activity of the digestive tract (both in animals and in man) is most intensive during the period of work and least intensive during the period of relative rest, serves as a basis for the following conclusions. "Digestive" activity of the duodenal smooth muscles can be regarded as optimal evidently because this activity fluctuates during digestion within certain limits: between maximal activity in the period of work and minimal activity in the period of rest outside digestion.

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FUNCTIONAL ROLE OF LUNG SURFACTANTS

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Solutions of surfactants freshly prepared from the rat lung (LS) accelerate absorption of oxygen on the phase boundary. Oxidized solutions of LS have an inhibitory action. It is postulated that the functional role of LS in external respiration is not confined to the lowering of surface tension and stabilization of the alveoli, but also involves participation in the absorption of oxygen and regulation of its transport through the air–blood barrier.

KEY WORDS: lung surfactants; surface-active substances; oxygen transport.

Lung surfactants (LS) play several important functions in external respiration. It has been shown that surfactants lower surface tension and reduce the work required for ventilation of the lungs, stabilize the alveoli, and prevent their atelectasis [6, 9, 12, 13].

The LS consist mainly of lipids, of which 80% are phospholipids [11], which have a higher coefficient of oxygen solubility than aqueous media [8]. Because of this property, the LS film on the surface of the alveoli, like the lipid components of cell membranes, must increase the rate of oxygen absorption from the gaseous phase [1, 10].

To test this hypothesis the effect of a residual film of LS on the kinetics of mass oxygen transfer was studied.

EXPERIMENTAL METHOD

Freshly prepared and oxidized solutions of LS, lecithin, and silicone oil were used as test materials. LS were obtained by the following method: 50 mg rat lung tissue was homogenized and mixed with 25 ml of 0.9% NaCl solution, after which the mixture was centrifuged for 10 min at 900g. The supernatant was recentrifuged at 65,000g for 1 h. The residue was

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