FREQUENCY PARAMETERS OF THE ELECTROGASTROMYOGRAM

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The task of assessing the functional state of the smooth muscles of the stomach under normal and pathological conditions can be undertaken by physicomathematical analysis of its myoelectrical activity, which is the electrophysiological equivalent of the motor-evacuatory activity of this organ [1].

In this paper we give a classification of the basic electrical rhythm of the stomach, recorded in the fasting state and during digestion in healthy subjects and patients with clinically verified duodenal ulcer.

EXPERIMENTAL METHOD

The material of the study consists of measurements of the basic electrical rhythm of the stomach, made outside and during the period of digestion (a test meal of 100 g of stewed lean beef) with the aid of capacitive electrodes [2] in 53 healthy young subjects (medical students, 28 women and 25 men) aged from 18 to 30 years and in 48 patients with endoscopically or roentgenologically confirmed peptic ulcer of the bulb of the duodenum without stenosis and in the absence of complications (27 men and 21 women), aged from 20 to 40 years. Myoelectrical activity of the stomach was recorded by means of a standard electrical measuring apparatus in the 0.01-100 Hz frequency band, with a differential biopotentials amplifier of UBP-2-03 type with symmetrical input, and an OMP-4-01 medical oscillograph. Myoelectrical activity was recorded with the aid of capacitive electrodes located on the patient's body at the projection point of the antral portion of the stomach, continuously for 1.5-2 h at a speed of 2 mm/sec. All recorded values of the period T [2] of the basic electrical rhythm of the stomach were then subjected to statistical analysis.

EXPERIMENTAL RESULTS

A comparative study of the nyoelectrical activity of the stomach, recorded by means of surface (capacitive) electrodes and a catheter-bioelectrode [3], introduced perorally into the atrial portion under roentgenologic control, showed that the basic electrical rhythm of the stomach recorded directly from its wall by means of a suction electrode, corresponds extracorporeally to synchronized quasiharmonic waves of potential, more specifically to slow surface electrical waves with a frequency of about 0.05 Hz. This fact is the basis for acceptance of the switch from analysis of the basic electrical rhythm of the stomach to the study of its slow surface electrical waves.

The writers showed previously [2] that physiological information on the state of the stomach is contained in the frequency properties of its basic electrical rhythm. Accordingly, knowledge of the distribution function F(x) of the period T of the slow surface electrical waves of the stomach makes it possible to represent the electrogastromyogram as a set of probabilities of missed diagnosis of the disease and of a false alarm (overdiagnosis), induced by different criteria of computer diagnosis (Table 1). With this approach, estimation of the functional state of the smooth muscle of the stomach can be reduced to determination of the critical value x_0 of a measurable feature, in order to devise a unidimensional set X into two classes — y_1 and y_2, corresponding to two different functional states of the organ tested.

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TABLE 1. Probability of Overdiagnosis and Misdiagnosis of Disease during Diagnosis of Duodenal Ulcer from the Basic Electrical Rhythm of the Stomach

Method of computer diagnosis	Boundary value T_0, sec	Probability of overdiagnosis p (H_{21})	Probability of missed diagnosis p (H_{12})
Minimal risk method	21,014	0,179	0,183
Minimax method	21,091	0,108	0,172
Neyman–Pearson method	21,098	0,146	0,168

Legend. 1) estimates given for practice sample (see: "Experimental Method"). 2) estimates obtained during digestion, in the course of 1 h after taking a test meal.

The procedure of division of the electrogastromyographic curves in this case consists of realization of the following deciding rule:

$$\begin{aligned} &\text{if } x \leq x_0, \text{ the diagnosis } y_1 \text{ is valid} \\ &\text{if } x > x_0, \text{ the diseases } y_2 \text{ are present.} \end{aligned} \qquad (1)$$

In accordance with rule (1) the probability of overdiagnosis $p(H_{21})$ is the product of the probabilities of state y_1 and an error of the first kind, whereas the probability of missed diagnosis of the disease $p(H_{12})$ is the probability of occurrence of the independent events y_2 and $x \leq x_0$.

If will be clear from Table 1 that the probability of correct diagnosis of the functional state of the stomach depends on the selected criterion of optimality. The use of various classifiers of the theory of statistical solutions shows that in the problem under examination the minimum of errors of the first and second kind is determined by the Neyman–Pearson criterion. Analysis of the results shows that duodenal ulcer is characterized by a considerable increase in dispersion and entropy of the basic electrical rhytym of the stomach compared with normal. subjects. The mean value of the period T of the basic electrical rhythm of the stomach in patients with duodenal ulcer was found to exceed the value of this parameter in normal subjects by 1 sec.

Our experience of analysis of electrogastromyographic measurements indicates that the period T of the basic electrical rhythm of the stomach is an invariant information parameter relative to interference, though this cannot be said of the amplitude of this rhythm, for it depends essentially on the patient's body weight (when recorded by surface electrodes), the anatomical features of his stomach, and so on.

In conclusion it must be stressed that solution of the problem of electrophysiological diagnosis of the functional state of the gastric smooth muscle can be reduced, in the general case, to analysis of the frequency properties of the basic electrical rhythm of the stomach.

Duodenal ulcer is thus accompanied by a marked increase in dispersion and entropy of the basic electrical rhythm of the stomach compared with the normal state, and information about the functional state of the gastric smooth muscle is contained in the frequency parameters of its basic electrical rhythm.

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