Review

Electrogastroenterography in clinical practice

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Abstract: The review contains the information on the basics of electrophysiological evaluation of motor-evacuator function of stomach. It describes the main methods for registration of electric activity of stomach and intestine, characterizes the registered parameters, and gives modern data on its clinical application.

Keywords: electrophysiology, peripheral electrogastroenterography, motor evacuator function, stomach, intestine

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One of the most important properties of smooth muscle tissue of gastrointestinal tract (GIT) is its ability to spontaneously generate and conduct electric potentials by pacemaker areas [1-5]. Its work causes the appearance of regular, rhythmic fluctuation of stomach and intestine called slow waves (SW) or basal electric rhythm (BER) [6-9].

Pacemaker areas are detected at the border with cardia section of the stomach and its pre-pyloric part [1, 10-12], at the duodenum on the level of influx of bile and pancreatic ducts, and in the ileum [13]. It is thought that the pacers are the interstitial Kachal cells [14, 15].

Basis electric activity (EA) that is constantly present is accompanied by periodically appearing activity potentials called spike activity [11].

There are basis (second), minute, hourly electric rhythms and food consumption rhythms called SW-activity [2, 11, 13, 16, 17].

BER frequency is 1 to 22 fluctuations per minute [1, 18].

Specificity of BER frequencies for each GIT section described by W.C. Alvarez [4, 19], was the base for introduction of electrophysical methods of EA study of different GIT sections.

In 1981 V.G. Rebrov developed the classification of GIT bioelectric waves [9]. Frequency range of the stomach is 2 to 4 cycles per minute [5, 12, 20].

Consumption of food, several pharmaceuticals, as well as pathologic processes of the abdominal cavity cause the disappearance of migrating minute complex, instead of which persistent EA amplification appears up to the end of stimulating factor [21].

Electrophysiological appearances of periodic activity of GIT are the change of range and frequency parameters of SW activity and spike activity intensity [5, 10, 11, 20-22].

During the last 50 years there was proven close relation between EA and motor activity of GIT. It was established that BER defines maximal possible frequency of smooth muscles contraction of stomach and intestine, and its frequency matches the frequency of contraction of smooth muscles of studied section of GIT [11, 13, 23-26].

BER is the base for coordination of the work of different GIT sections; however the appearance of contractions and their intensity are related to spike activity parameters [13].

EA is defining relative to the appearance of smooth muscle contractions of stomach and intestine with appearance of contractions depending not only on stimuli present but on readiness of the muscle itself to answer to it with contraction [6, 8, 9, 11, 20, 23, 27].

In order to evaluate EA of GIT organs both invasive and non-invasive study methods are used. The first include electromyography (EMG), the second – cutaneous electrogastrography (EGG) and electrogastroenterography (EGEG) [5].

EMG of GIT organs is performed using electrodes implanted in their mucosa or using suction electrodes on special catheters entered in the stomach, large intestine or small intestine [5, 10, 11, 27, 28].

The disadvantages of EMG include invasiveness and difficulty, registration of only local EA in the places of electrodes implantation [10].

In 1922 W.C. Alvares proposed the EGG method which is the registration of the change of total electric potential of the stomach from the human body surface by installing active electrode above stomach in the view of its antral section [4].

First fundamental studies of EGG in our country were performed by M.A. Sobakin [11], after which the active use of EGG in experimental and clinical studies began [17, 18, 29-40].

Thus, M.I. Kuzin et al. (1985) consider EGG one of the primary methods for evaluation of ulcer stenosis severity [41].

O.L. Notova (1987) and N.S. Tropskaya (1994) proved the possibility of the detection of hourly rhythms of gastric and intestinal EA using EGEG method including the registration of the changes in total electric potential of stomach and intestine from the human body surface [13, 23]. The beginning of use of the method was related to the multichannel electrogastrograph development [27].

The validity of the method of cutaneous registration of GIT biopotentials was proven on the stomach frequencies using parallel X-ray, edoscopic study and EMG [5, 11-13, 43, 44].

In Russian Federation EGEG is usually called peripheral EGEG (PEGEG) [23, 37].

The advantages of PEGEG over EMG include non-invasivity, possibility of long-term and multiple use, and also of simultaneous evaluation of integral EA of different stomach sections. The method is of higher information value than EGG since it also provides for evaluation of EA of different intestinal sections [1, 17, 23, 29, 30, 38, 39].

All the quantity parameters of EA GIT are divided into amplitude and frequency, as well as absolute and relative [1, 37].

Amplitude parameters include amplitude (A) of the fluctuations of bioelectric potential on BER frequencies of reviewed GIT part and the power (P) spectrum. Usually there are calculated total power (Ps) and power on the BER frequencies for different GIT sections (Pi) [1, 17, 37].

The frequency parameters involved dominating and average frequency of PEGEG in the BER range of the GIT section [18].

Relative amplitude parameters are the ratio of the parameter calculated for one or several GIT sections to the similar parameter for other(-s) GIT sections, as well as ratio of the values for the same parameter calculated in the different time moments and their derivatives [17, 18].

D.B. Zakirov (1994) in order to evaluate the rhythmic of different GIT sections introduced the rhythmic coefficient which is the ratio of the length of spectrum envelope to the length of the spectrum section of study section and also characterizes the rhythmic of the contractile activity and the propulsive peristalsis [17].

In order to evaluate the rhythmic of GIT EA the “instability of dominating frequency” is determined, as well as the respective spectrum power – “index of power instability” [23].

The most used frequency parameter is the percent content of the parameters in the frequency ranges 2-4 Hz, 0-2 Hz and 4-10 Hz, called normo-, tachy- and bradygastrias [9, 21, 23, 37].

Coordination of GIT operation shall be evaluated as the range of the amplitude or power of PEGEG on the frequencies of superior section to the similar parameter of the inferior section called “ratio coefficient” (Pi/Pi+1) [30, 32, 37-40].

S. Yochitomi et al. (1996) considered the work of stomach and intestine coordinated when the amplification of PEGEG range after food load in the stomach range was accompanied by the amplification of EA in the intestine range with short delay [42]. Y. Koike et al. (1995) introduced the term of coordination index defined by them as the ratio of the coefficient of increase of EA amplitude of small intestine to the coefficient of increase of EA amplitude of the stomach after food load [46].

To evaluate the degree of compensation of stomach motorics in the patients with ulcerative pyloroduodenal stenosis and the diagnostics of its post-operational disorders there were proposed the compensation parameters for electric and peristalsis activity of stomach [30].

Food stimulation is a common recognized criteria for evaluation of GIT functional state, causing in the pathological conditions the change of frequency parameters depending on its type [3, 4, 23].

The most widespread area of PEGEG use is the surgical pathology of the intestinal organs. The purpose of PEGEG use in the post-operational period is the evaluation of severity of GIT motor function disorder justified by post-operational paresis of stomach and intestine, prediction of possible complications and evaluation of effectiveness of the treatment performed [1, 17, 18, 30, 32, 34, 40].

PEGEG is most frequently used for ileus of different etiology [4, 11].

L.K. Kulikov, A.A. Smirnov, I.M. Jajanidze, after studying the electric activity of gastrointestinal tract in the patients with acute destructive pancreatitis established the connection between disorders of motor-evacuator function of gastrointestinal tract and purulent complications of pancreonecrosis [32].

A.A. Smirnov proposed to use the coefficient of severity degree of gastrointestinal tract paresis in the patients with peritonitis in order to make the objective diagnostics of paralytic intestinal obstruction [40].

There are the data on its use at gallstone disease [33, 45] and mesenteries thrombosis [37].

Lately PEGEG is gaining the increasing popularity in therapeutic gastroenterology with the objects of interest of the investigators being not only the separate nosologies but also functional disorders such as functional dyspepsia [47, 48], duodenal hypertension [36] and gastroesophageal reflux disease [31].

PEGEG is also used for evaluation of the effect of different pharmacologic drugs on the parameters of EA of stomach and intestine [18, 21, 36].

Information on electrophysiological evaluation of violations of gastric motor-evacuation function at the ulcer disease using PEGEG are not plentiful and reflect only the most general principles of diagnostics of pyloroduodenal stenoses and post-operational gastrostases [1, 17, 30].

Prospective direction for use of PEGEG is the use of multi-dimension statistic analysis with creation of mathematic models of gastrointestinal tract motorics disorder [30].

Based on the cluster and discriminate statistic analysis of PEGEG parameters there were detected hyper-and hypomotor types of gastric motorics disorder in patients with subcompensated pyloroduodenal stenosis [30].

Electrophysiological methods for evaluation of motor evacuator GIT function are being introduced to the modern clinical practice with the increasing frequency and are the prospective direction that allows detecting its disorders and perfecting the treatment methods.

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