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Perspectives of the application of gas discharge visualization for the estimation of organism condition at critical states

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The gas discharge visualization technique (GDV) is being actively used now in various spheres of medicine – therapies, oncology, obstetrics and gynecology, psychophysiology (*B.L. Gurvitz et al., 1998; R.A. Alexandrova et al., 1999, 2000, 2001; A.U. Azheulov, 2000; P.V. Bundzen et al., 2000; V.S. Gimbut, 2000; P.V. Bundzen, L.E. Unenstahl, 1999; S. Kolmakow et al., 1999*).

The aim of the work consisted in the estimation of informativeness of the GDV technique from a position of anaesthetist-reanimatologist under functional investigation of patients, subject to planned surgical interventions.

Methods and materials of research

10 fingers of healthy persons and patients having disorders were the object of research. GDV-grams were registered in modes "without filter" and "with filter" by means of "GDV Camera", developed under the direction of Prof. K.G. Korotkov.

The obtained gas discharge images were processed with the help of specialized software "GDV Diagram", "GDV Processor" and "GDV-Tolerance" (developed by "Kirlionics Technologies International").

The control group consisted of 35 practically healthy people and the main – of 115 patients with chronic surgical pathology of the organs of abdominal cavity. Not only the differences of GDV-grams of healthy and diseased persons were investigated, but also the influence of some factors upon their parameters (sex, age, main pathology, etc.) was estimated.

For the purpose of investigation of effectiveness of the GDV technique for the estimation of functional state of organism, all patients were divided into three groups by the initial (before operation) severity of state, according to the system of assessment accepted in military-medical institutions of the Armed Forces of Russia (analogous to ASA system used in the USA).

The 1st group consisted of patients, whose somatic state was assessed as satisfactory. The 2nd group was made up by patients with moderate severity of state. The 3rd group consisted of patients in severe and critical state.

The indices of GDV-grams were compared with the data obtained in the course of clinical and instrumental investigation of patients in the following stages:
I – the day before planned surgical operation; II – 1st hour after operation; III-VI – 2nd – 5th days of postoperative period.

With the purpose of research of opportunities of application of the GDV technique for the monitoring of state of patients, including assessment of intensity of postoperative stress,

all patients were divided into four groups depending on the anatomic zone which had been operated and taking into account the technique of operation. The 1st group consisted of 47 patients, who had been subject to surgical operations in the zone of gall bladder and bile-excreting tracts by laparoscopic approach. The 2nd group consisted of 14 patients, who had been operated for gall bladder and bile-excreting tracts by laparotomic (open) approach. The 3rd group involved 18 patients, who had been operated for stomach and duodenum. The 4th group consisted of 12 patients, subject to operations for various parts of large intestine.

Organism's reaction to the operative trauma was investigated taking into account the main indices of GDV-grams apart from changes of clinical picture, hemodynamics and blood biochemical parameters (glucose, transferase, etc.).

In order to investigate the opportunity of application of the GDV technique for the purpose of predicting unfavorable flow of early postoperative period, patients with acute postoperative pancreatitis (APP) were selected from the main group.

Investigating the opportunities of using GDV for the determination of the level of anxiety of patients, the level of anxiety was assessed by the scale of Spilberger-Hanin for 19 patients before the operation apart from the registration of dynamic video files of GDV-grams and their processing in "GDV-Tolerance" program.

Results of research

As a result of analysis of data of the examination of patients of the main and control groups, reliable differences of GDV-gram parameters processed both in "GDV Diagram" and "GDV Processor" programs were found. These differences concerned the main characteristics of gas discharge image (GDI): "area", "brightness", "density of glow", as well as "irregularity of outer contour" of GDV-gram. We registered the increase of GDI parameters of patients with disorders as compared to that of practically healthy people.

Apart from pathology, age and sex of patients influences GDV parameters. The increase of most of the parameters with age was found. The highest indices were registered for patients older than 60 years, which indicates that the age norm of GDV-gram parameters shall be determined.

Thus, GDV-gram parameters of patients with abdominal pathology have a number of features. However, GDV-grams are very individual and depend not only on the pathological changes in the organism, but on sex and age, as well as probably on other factors. All that, at the given level of development of the method, enables to consider it appropriate not so much for comparative research or diagnostics of diseases rather than for dynamic control of change of bioenergy status of patient.

Research of informativeness of the GDV technique for the estimation of functional state of patients in preoperative period

The analysis of GDV-gram parameters of groups of patients by the severity of their somatic state showed that there were reliable differences between them. Patients of the III group with the most severe somatic state, at that, were on average characterized by smaller values of GDV-gram parameters.

Thus, we can assume that the decrease of GDV-gram parameters of patients with the most severe somatic state is conditioned by low functional reserves of their organism.

Assessment of anxiety of patients in preoperative period by the GDV technique

From the point of view of anaesthetist-reanimatologist, an important component of research of patient is the assessment of patient's psychological status. One of the main components of this status is the state of anxiety, which undoubtedly changes under the influence of stress factors.

We made use of data obtained in the course of prospective research, performed for 19 patients (7 men and 12 women) in the age from 32 to 72 years. We analyzed the initial data of patients, received with the help of clinical, instrumental and laboratory methods of research. As a result of comparative analysis of groups of patients with different level of *individual anxiety* and *reactive anxiety* (according to the scale of Spilberg-Hanin) basing on GDV-graphy parameters, we found the dependence between the level of individual anxiety and GDV parameter "Level of tolerance", on the one hand, as well as between the level of reactive anxiety and GDV parameter "Level of bioregulation" – on the other.

The obtained results indicate that the parameters of "dynamic" gas discharge images correlate with the assessment of anxiety by the scale of Spilberg-Hanin, which enables to use the GDV technique for objective assessment of the level of anxiety of patients before surgical operations.

Assessment of the opportunity of using GDV technique for the monitoring of functional state of patients in postoperative period

We analyzed the dynamics of GDV-gram parameters in postoperative period after planned operative interventions of different degree of severity. It was found that the most expressed changes of GDV-gram parameters took place during the first days after operation. Reliable increase of most of GDV-gram parameters was found, at that (in "GDV Diagram" program), as compared to the initial level when registered in the first hour after operative surgery. The indices of "normalized area" and "total area" in "GDV Processor" program changed in the same way. The character of outer contour of GDV-gram changed in response to operative trauma, as demonstrated by the increase of "fractality" and decrease of "form coefficient".

We suppose that such a dynamics of GDV-gram parameters is connected with tensity of functioning of all systems of the organism in response to operative trauma, i.e. with operative stress.

With the purpose of investigation of the possibility of using GDV technique for the assessment of intensity of operative stress, the dynamics of GDV-gram parameters obtained during the first hour after operative interventions of different degree of severity was analyzed. The most pronounced changes were found for patients after operations for gall bladder, bile-excreting tracts and stomach, performed by a traditional laparotomic approach. That is connected with the fact that these groups had been subject to many extended surgeries, as a result of which these operations were the longest and the most traumatic. The changes of parameters of GDV-gram area under large intestine surgeries turned out to be less pronounced. The changes of these parameters were smaller under laparoscopic operations.

Thus, we can assume that the GDV technique can be used for the assessment of intensity of operative stress.

The analysis of dynamics of GDV-gram parameters in early postoperative period after one-type surgeries in different subgroups demonstrated that the most pronounced changes were registered for the patients of the I subgroup (initial state – satisfactory). A less pronounced reaction of the GDI parameters of "area" was registered for patients with high degree of severity of state (III subgroup). The represented dynamics of GDV-gram parameters for patients with a comparatively high degree of severity of somatic state is likely to reflect the decrease of compensative opportunities of organism's reaction and organism's reactivity. Moreover, after more extended and long operations (stomach and large intestine surgeries, 3rd and 4th groups correspondingly) the changes of parameters of GDV-gram area even became differently directed.

We suppose that the decrease of parameter of "glow area" after severe surgeries characterizes the state of distress and is the reflection of low functional reserves of the

organism. Perhaps, as a consequence patients stayed longer in intensive care units and at hospital, as well as showed higher frequency of development of complications and fatal outcomes in early postoperative period.

Thus, basing on the obtained data we can conclude that the GDV technique enables to monitor functional state of patients in postoperative period.

Assessment of the opportunity of using GDV technique for the prognosis of unfavorable flow of early postoperative period

“Acute postoperative pancreatitis” (APP) is considered to be a serious complication of operations for abdominal area. This diagnosis APP was verified by us on the basis of clinical picture, data of laboratory and instrumental diagnostics for 12 patients.

GDV parameters for these patients were compared with the data obtained for patients with favorable flow of postoperative period. Reliably high values of parameters of “glow area”, “density” and fractality” of GDV-grams were typical of APP patients. The parameter of “average brightness” was reliably lower for them. It is worth mentioning that these differences had yet been registered in preoperative period and were the most pronounced in the first days after operation, when there was no reason to set the diagnosis of APP according to the results of clinico-laboratory research. These data indicate that the GDV technique is rather sensible, enabling to assume a possible inadequate reaction of organism to damage.

Thus, the results of our research, on the whole, enable to maintain that the GDV is a perspective technique for anesthesiology and reanimatology for functional examination of patients and monitoring of their state in perioperative period.