Identifying Patients with Colon Neoplasias with Gas Discharge Visualization Technique

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Abstract

Objective: To perform an initial assessment of the potential of using the gas discharge visualization (GDV) technique to identify patients with colon neoplasias.

Methods: The GDV camera (also known as the electrophotonic imaging camera) was used to assess the participants. Colonoscopy was performed on all 78 participants, followed by a GDV scan. The control group consisted of 22 people. An endoscopic examination identified colon tumors in the remaining 56 participants. Participant ages ranged from 45 to 86 years (mean, 64.6 ± 1.2 years). The study analyzed GDV images of each patient's fingers, presenting a whole-body view, as well as separate sectors corresponding to the organs in question.

Results: There was a significant number of differences between the control group and the patients with colon tumors. The dynamic of the parameters was examined as the level of tumor dysplasia (neoplasia) varied. The values of the following parameters decreased in the control group as compared to the patients with cancerous polyps: normalized luminescence area, internal noise, contour radius, and average luminescence intensity. The values of the following parameters increased in the control group: radius of the inscribed circle, contour line length, area of luminescence, contour line fractality, contour line entropy, and form coefficients.

Conclusion: This pilot study demonstrated a statistical difference between the GDV parameters of patients with colon tumors and the control group. These findings warrant a more in-depth study of the potential for GDV technique in screening programs.

Introduction

According to the International Agency for Research on Cancer, colon lesions rank third in the world for incidence rate and rank fourth in the world for the number of deaths.[1] Overall, the lifetime risk of developing colorectal cancer (CRC) is about 1 in 20 (5%). It was expected that CRC would be responsible for more than 50,000 deaths in 2014.[2] In Russia, among all types of cancer, incidence of CRC ranks third, and second for death rate. Further, in 2011, the prevalence of malignant neoplasms of the colon was 200 per 100,000 people.[3] Although more than 50% of all cancer cases are diagnosed in people aged 60 years and older, the disease is increasingly diagnosed at a young age, especially in members of affected patients' families and those with hereditary forms.

Timely detection of precancerous changes is vital for determining duration of survival and success or failure of the treatment. Most relevant in the fight against cancer are screening programs for diagnosing diseases at an early stage, before the classic presentation of the disease develops. Occult blood tests, often used for mass screening for colorectal cancer, unfortunately do not have the desired accuracy, sensitivity, and specificity. Thus, there has been growing worldwide focus on finding other noninvasive screening methods. Along with molecular biological methods, computed tomographic colonography, and capsule colonoscopy, increasing attention is being paid to electrophysiologic methods.

Application of computer technology in the processing of electrophysiologic information can standardize the procedure, substantially accelerate access to research results, and reduce the influence of subjectivity. Electrodiagnostic techniques, such as electroencephalography and electrocardiography are extensively used in medical practices worldwide.[4] A promising method, already used in 62 countries to great success, is bioelectrography based on the Kirlian effect. This effect occurs when an object is placed on a glass

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plate and stimulated with a current, resulting in the presentation of a visible glow, the gas discharge. The gas discharge visualization (GDV) camera (also known as the electrophotonic imaging [EPI] camera) is being used for the study. With GDV/EPI bioelectrography cameras, using electrophotonic imaging through gas discharge visualization, the Kirlian effect is quantifiable and reproducible for scientific research purposes. In a study, captured images of all 10 fingers of each human participant provided detailed information on the participant's psychosomatic and physiologic state.[5] The GDV/EPI camera systems and their accompanying software are the most effective and reliable instruments in the field of bioelectrography.[6–10] GDV/EPI applications in other areas are being developed as well.[11–19]

Through investigation of the fluorescent fingertip images, which dynamically change with emotional and physical health states, one can identify areas of congestion or health in the whole system. Each generated fingertip photograph is analyzed by sector division, according to acupuncture meridians. In Germany, Dr. Peter Mandel[20] over many decades has developed this intricate and well-defined method of seeing into the entire body through the fingertips. Using the GDV/EPI technique, researchers created a diagnostic table based on years of their own clinical field testing, the sector basis of which differs slightly from that of Dr. Mandel.[21]

The parameters of the image generated from photographing the surface of a finger under electrical stimulation creates a neurovascular reaction of the skin, influenced by the nervous-humoral status of all organs and systems. Thus, images captured by GDV/EPI register an ever-changing range of states.[22] In addition, most healthy people's GDV/EPI readings vary only 8%–10% over many years of measurements, indicating a high level of precision in this technique. Specialized software converts these readings into parameters, which elucidate the person's state of well-being at that time.[23]

One of the first studies of cancer diagnosis was by Gurvits et al.[24] The material for the study were plasma samples of patients with cancer of various organs (both with the absence and the presence of distant metastasis) and blood samples of healthy donors. For all samples, the values of discharge parameters of blood for patients with cancer were significantly higher than values for healthy people. Chouhan et al.[25] examined the GDV images of fingers of patients in different stages of cervical cancer, showing a significant difference from the image parameters of healthy patients. Through GDV monitoring of patients with squamous cell lung cancer, Vepkhvadze et al.[26] showed that the results of GDV evaluation and monitoring of the functional status of the patients correlated with clinical, laboratory, and instrumental studies in 90%–96% of cases. Seidov[27] identified some correspondence between GDV parameters and the presence of tumors in different parts of the colon. However, no systematic research has addressed the diagnosis of colon tumors using GDV.

The aim of the current study was to investigate the possibility of using GDV to identify patients with colon tumors.

Materials and Methods

To achieve this goal, the GDV technique was used to investigate the differences between patients in the control group (no precancerous conditions: healthy state according to video colonoscopic evaluation) and patients with benign lesions (hereinafter, polyps) and malignant tumors (hereinafter, cancer) of the colon. All lesions were diagnosed with high-definition video endoscopy and narrow band imaging and were confirmed morphologically.

Seventy-eight people, including 25 men and 43 women, age 45–86 years (mean age, 64.6 ± 1.2 years) were studied. All people were white. The control group consisted of 22 people (10 men and 12 women) age 45–63 years (mean age, 52.4 ± 1.3 years). Among the remaining 56 participants, colon polyps were detected in 45 and cancer in 11.

For every participant, GDV images of all 10 fingers were taken in the first half of the day at least 1 hour after the meal.

Computer analyses of GDV images were performed by using the GDV Compact (Kirlionics Technologies International, St. Petersburg, Russia) and GDV Bio-Well (Bio-Well, Narva, Estonia) devices. Groups were tested for normality by using the Kolmogorov-Smirnov test and for the presence of differences by using a t-test (SPSS Statistics 17.0, SPSS Inc., Chicago, IL). Left and right index fingers were imaged, in accordance with the principles of Traditional Chinese Medicine; acupuncture channels correlated with the state of the different parts of the colon are located on these fingers. In accordance with these principles, GDV software calculates parameters of the particular sectors of the GDV image, corresponding to different parts of the colon system. The following were studied, for a total of 216 indicators: the whole images of the index fingers (Fig. 1) and sectors correlated with the colon system (cecum, ascending colon, transverse colon, descending colon, sigmoid colon, rectum) and the parts of the spine relevant to the innervation of the colon (lumbar compartment, sacrum, and coccyx). The parameters used are described in the Appendix.

Results

In accordance with the first objective of this assessment, differences between the control group and all patients with neoplasms of the colon were revealed. Statistically significant differences ($p < 0.05$) were seen for 76 of 216 indicators, 21 of which had a very high level of significance ($p < 0.001$).
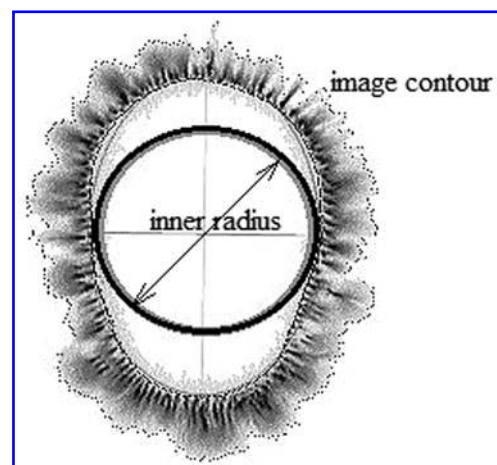

FIG. 1. Gas discharge visualization image of a finger with some indicated parameters.

TABLE 1. PATTERNS OF CHANGE IN PARAMETERS
OF THE STUDY GROUPS WITH INCREASING DEGREE
OF NEOPLASIA (AVERAGE VALUES)

Parameter	Control group	Polyp group	Cancer group
Control → polyp → cancer			
Normalized area	1.41 ± 0.12	1.27 ± 0.06	1.09 ± 0.04^a
Inner noise	40.90 ± 3.00	31.11 ± 2.51	23.32 ± 2.01^b
Isoline radius	14.21 ± 0.45	11.46 ± 0.32	10.45 ± 0.42^b
Intensity	86.65 ± 0.12	78.04 ± 0.08	75.19 ± 0.05^b
Control ← polyp ← cancer			
Inner circle radius	46.05 ± 1.53	54.45 ± 1.63	59.37 ± 1.04^b
Isoline length	950 ± 27	1025 ± 16	1105 ± 40^b
Area	9620 ± 225	10760 ± 215	11427 ± 115^b
Isoline fractality	1.60 ± 0.02	1.63 ± 0.04	1.71 ± 0.01^b
Isoline entropy	1.57 ± 0.03	1.65 ± 0.02	1.74 ± 0.01^b
Form coefficient	11.14 ± 0.54	17.46 ± 0.60	20.52 ± 0.45^a

Values are expressed as mean ± standard deviation.
[a]$p < 0.001$.
[b]$p < 0.01$.

The differentiating parameters were the radius of the inscribed circle, normalized area, percentage of internal noise, and shape form characterizing the irregularity of the outer contour of the GDV images. Differences were largely found for the transverse colon and ascending colon. This can be explained by the fact that most surveyed patients had pathologic changes in these parts of the colon. Table 1 shows the average values of the parameters and their relative frequency of occurrence between all significant parameters in the studied groups with increase in the degree of tumor neoplasia.

Table 1 shows that parameters have different tendencies in the line control → polyps → Cancer. Collection of a larger database of specific cases will allow use of these parameters to create a mathematical model to distinguish different groups.

Dynamics of GDV parameters in the development of the disease were traced, with the same tendency as demonstrated in Table 1: Values of the radius of the inscribed circle, contour length, and form coefficient and area were increased, while the normalized area and the percentage of internal noise were reduced.

Table 1 shows characteristics for the whole image of the index finger averaged on the right and left hands. This shows the same tendency found for the specific sectors related to colon system. Figure 2 compares the inner circle radius for different sectors ($p < 0.05$).

Discussion

A statistical analysis of GDV parameters was performed among 7495 people whose data are stored in the authors' database. It is a varied population ranging in age from 18 to 100 years and consists of both men and women; most are generally healthy, and some have chronic diseases. Data obtained during this study were not included. As an example, Figure 3 shows a histogram of the radius of the inscribed circle distribution. Vertical lines denote the mean values and standard deviations. This range may be accepted as typical of the parameters for generally healthy people. Arrows indicate the range of parameters for colon cancer. This range is clearly distinguishable from the norm band, which confirms the validity of the obtained data.

At the same time, these high values for the radius may be specific not only to cancer but also to other health issues. Further research will demonstrate whether cancer can be distinguished on the basis of multiple GDV parameters.

The stage of neoplasia correlates with decreased intensity of luminescence. Further, decreasing percentages of internal noise characterizes the level of scattered biophotons radiating from the skin. The lower the activity of physiologic systems, the weaker the biophotonic radiation. The value of the parameter normalized area, which reflects the extent of adaptation of the organism, decreases as well. The smaller this value is, the fewer the bodily resources for adaptation. As the stages of neoplasia progress, entropy increases; this reflects the balance of regulation. So it can be argued that the distinguished regularities of the GDV parameters dynamically reflect a feature of the physiologic systems of the body.

In conclusion, this pilot study showed the feasibility of using the GDV technique to identify patients with colon neoplasias. The main distinguishable parameters for all groups were the radius of the inscribed circle, normalized area, percentage of internal noise, and form coefficient. These initial positive results should encourage the consideration of more in-depth and detailed studies of GDV, with the potential of eventual use in screening programs.
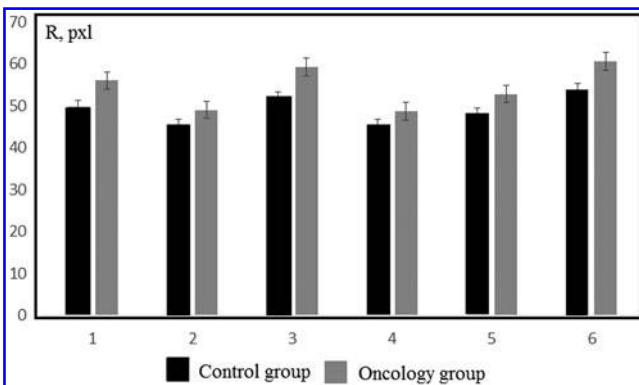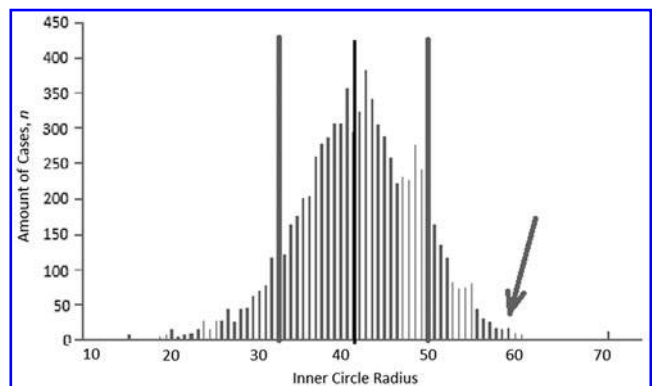

FIG. 2. Comparison of the inner circle radius parameter for different sectors: 1, whole image; 2, ascending colon; 3, transverse colon; 4, descending colon; 5, sigmoid colon; 6, rectum. Values are given in pixels (pxl); the bars indicate standard error of the mean.

FIG. 3. Histogram of the radius of the inscribed circle distribution based on analysis of 7495 patients. *Arrow* indicates the range of parameters typical for colon cancer patients.

Author Disclosure Statement

No competing financial interests exist.

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Appendix

APPENDIX A. PARAMETERS OF GAS DISCHARGE VISUALIZATION IMAGE

Figure 1 shows a computer-processed gas discharge visualization (GDV) image represented by a luminescent halo around the finger. The following parameters of a GDV image were calculated on the basis of the principles of image processing:

Form coefficient: Calculated according to the following formula: $FC = Q = k \times L^2/S$, where L is the length of an image's external contour and S is the image area (relative units).

Inner circle radius: radius of the circle inscribed in the inner oval (fingerprint).

Intensity: relative brightness of image pixels measured in computer units from 0 to 255 (pixels).

Internal noise: amount of light in the inner oval (fingerprint) (relative units).

Isoline entropy: ratio of an image's external contour to its internal contour (pixels).

Isoline fractality: fractal dimension of the external contour represented as quasi-infinite line (relative units).

Isoline length: length of the external contour of an image (pixels).

Isoline radius: average radius measured from the center of an image to the external contour (pixels).

Luminescence area: amount of light quanta generated by the subject in computer units (pixels)—the number of pixels in the image with brightness above the threshold.

Normalized luminescence area: the ratio of image area to the area of the inner oval (representing fingerprint) (relative units).