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High-frequency Coronal Discharge, Infrared Thermography and Visual Acuity Measurements of Bioelectromagnetic Influence

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Bioelectromagnetic influence on the eyes of a group of 336 subjects with various vision disorders: amblyopia, myopia and hypermetropia were investigated with high-frequency black-white and color coronal discharge, infrared thermography and visual acuity measurements. The authors have performed registration of the biggest part of electromagnetic fields – infrared and electric fields. Positive correlation with r=0.55-0.65 at a level of significance of $p<0.01$ was found between the temperature change (connected with vasodilation) in the influenced areas and the average change of visual acuity (visus). In the cases without correction, Student's t-test of visus values for both eyes before and after bioelectromagnetic influence lead to t=6.0-6.7 at significance level $p<0.001$ and average increase of 14.5%. In the cases of refraction amblyopia, for the difference in both eyes

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with correction,t was equal to 6.7-7.1 at significance level p<0.001 and the average visus was increased and was 25.5%. Concerning the correlation between the temperature difference and the effective width of the high-frequency corona discharge, it was found that r=6.0-6.7 at significance level p<0.001.The dependence of the bio effect on the stage of the vision disorder (light, medium, heavy) was investigated. A distinct regularity was found with a coefficient of correlation r ranging from 0,35 to 0,45 at significance level p<0,001 that the influence efficiency was highest in light disorders and lowest in heavy disorders. Single-factor dispersion analysis was performed concerning age-related dependence of the healing effect in cases of visual disorders. For the three groups: 4-10, 11-21 and 22-49 years of age, we found that F=4,4-4,6 at significance level p<0.01 corresponding to higher healing results at younger ages.

Keywords: High-frequency coronal discharge; infrared thermography; visual acuity; vision disorders; bio electromagnetic influence.

1. INTRODUCTION

The method of high-frequency coronal discharge has been applied in measurements of biophysical status of experimental subjects [1]. Moreover, new approaches have been discovered for characterization of alterations in biological functioning after certain types of influences [2]. Studies performed in the interval between 1998 and 2000 on the basis of 1120 black-and-white photographs showed that direct analysis of discharge glow cannot be used for diagnostic purposes [1]. The corresponding method of Antonov was known as Selective high frequency discharge (SHFD) [3]. Subsequently, in experimental subjects with different kinds of health @issues, needing medical help, Korotkov applied software processing of Images obtained with the GDV (Gas Discharge Visualization) method and demonstrated their diagnostic feasibility [4,5,6].

Direct interaction of coronal emission with photosensitive materials produces images of higher quality compared to photographic cameras. Thus, the lowest value of measured energy is 1.82 eV appearing as red color on the images, while the highest values correspond to blue (2.64 eV) and violet (3.03 eV). It should be pointed out that green color is not observed in coronal discharge from biological objects. On the other hand, digital photography is detects only blue and violet color [1]. Image characteristics are not influenced by the conductivity of experimental objects/subjects. However, they are dependent on the surface dielectric permittivity patterns [7,8,9].

Normal bioelectrical status of experimental subjects has been characterized with discharge photon emission energies greater than 2.54 eV. In some unique cases, values greater than 2.90 eV have been observed in yoga, sports and healing practitioners. On the contrary, values less than 2.53 eV have been measured in cases of reduced bioelectric activity. These findings justify further efforts towards application of high-frequency coronal gas discharge in advanced biophysical investigations [1,9].

In addition, significant progress has been achieved in the area of interrelation between biological and electromagnetic phenomena. Fritz-Albert Popp, Hugo Niggli et al. developed biophoton measurement methodology on the basis of low-intensity coherent electromagnetic emission from living cells. The method was able to detect differences between healthy and cancer cells [8,9]. Neshev and Kirilova studied possible non-thermal effects of electromagnetic waves on biological processes connected with proton and electron transfer [10,11]. Godyk and Gulyaev have conducted extensive research on extremely weak electromagnetic fields emitted from living organisms and their interconnection with biological regulation [12,13]. Their equipment included super conductive detectors built with Josephson junctions allowing for measurements of magnetic fields 10^{10} times weaker than the Earth's magnetic field.

Infrared thermography, another important method in biophysical status research, produces thermograms, images showing distribution patterns of infrared radiation (approx. in the range ~0.9–14 μm) emitted from material objects [14]. Therefore, thermograms are actually visual displays of the amount of infrared energy emitted, transmitted, and reflected from the surface of the object. Since infrared radiation is emitted by all objects with nonzero temperature according to Planck's formula for black body radiation, thermography allows to “see” the environment with or without visible illumination.

Thermal radiation intensity increases with the temperature, consequently warm objects are seen better on cooler environment background; mammals and warm-blooded animals are better visible in nature. That is why, thermography has many diagnostic applications and is often being used for breast diagnostics, tumor detection etc.

Most thermographic cameras use CCD and CMOS image sensors having the maximum of their spectral sensitivity in the visible range. Most frequently, a matrix of indium antimonide (InSb), gallium arsenide (GaAs), mercury telluride (HgTe), indium (In) and cadmium (Cd) is used. The latest technology allows for application of inexpensive uncooled microbolometer sensors. Their resolution varies from 160×120 or 320×240 up to 768×1024 pixels in the most advanced camera's models. Thermograms often reveal temperature variations so clearly that photographs are not necessary for further analysis. Usually, a block of focal planes of a thermo- imager can detect radiation in the medium (3 to 5 μm) and long (8 to 15 μm) infrared wave band, designated as MWIR and LWIR which correspond to two infrared windows with high coefficient of transmittance. Unusual temperature distribution on the surface of objects indicates potentials problems.

Nowadays, it is an established fact that some people with bio abilities have the ability to increase the temperature of treated a reason their patients' bodies by electromagnetic influence. As an example, Fig. 1 shows the effect of Christos Drossinakis' treatment on the back of a patient which is expressed as a significant temperature increase from 35.6 to 37.3 °C. Vasodilation plays an essential part in achievement of favorable health effects during bioelectromagnetic influence.

It should be noted from Sisodia et al. that the intensity of thermal radiation of the human body in the microwave (MW) range is much smaller than that in the infrared part of the spectrum [15]. In particular, at 17 cm wavelength, the intensity is ~10 times lass, so the heat detection in this spectral range requires equipment with much higher sensitivity. However, the advantage of such a method is that measurement range and depth of detection are much greater; therefore it is possible to obtain information about temperature parameters of internal organs and structures within the human body. However, resolution is significantly reduced and it is not possible to obtain detailed thermal images of investigated areas.

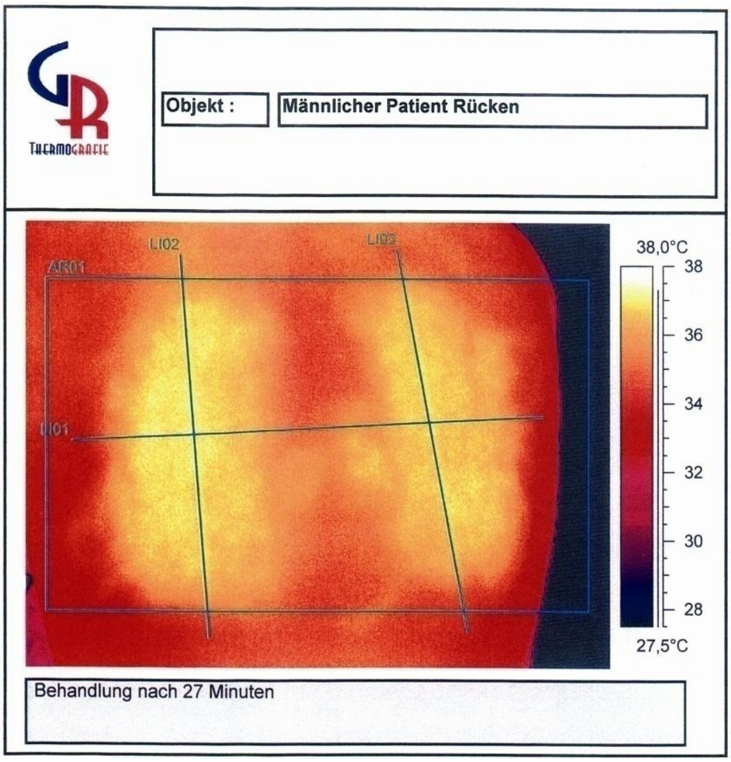


Fig. 1. Thermographic effect of bioelectromagnetic influence by Christos Drossinakis on the back of a male patient after 27 min of treatment

In general, Infrared thermography detects thermal infrared radiation emitted by the capillary network close to the skin surface and this is used in medicine for thermographic diagnostics. It is also possible to observe altered thermal signatures of dysfunctional areas of internal organs that are located near the skin. The aim of the present study is simultaneous application of high-frequency coronal discharge, infrared thermography and visual acuity measurements for characterization of bioelectromagnetic influence on experimental subjects with previously diagnosed vision disorders.

2. MATERIALS AND METHODS

2.1 High-frequency Coronal Discharge Photography

The functional scheme of the gas corona discharge device of Ignatov and Stoyanov is shown in Fig. 2 [1,16, 17].

Gas discharge emission was studied in a dark room with red filter lighting. It was registered with photosensitive paper or color film. The film Kodak was placed on the transparent Hostaphan® electrode with 87 mm diameter. It was filled with conductive liquid composed of 1% NaCl solution in deionized water. The rear side of the electrode was covered with thin copper coating. Investigated objects (water drops, human thumbs) were placed on the corresponding photosensitive material. Pulses with 15 kV voltage and carrier frequency 15–24 kHz were applied between the objects and the electrode copper coating.

Corona gas discharge was generated in the gap between investigated objects and the electrode producing electric glow around the contact area. Its electromagnetic emission in the ranges 380–495 and 570–750±5 nm illuminated the corresponding photosensitive material according to objects' specific properties [1,16,17]. Fig. 3 illustrates thumb placement on the electrode. Images produced by visible, UV and IR radiation were processed and analyzed with a dedicated software package.

An example of a thumb corona discharge with black-white photograph is shown in Fig. 4 .The shape of the discharge is characterized with its effective width R_{eff} which is a function of R_l, $R_r$and R_f, the widths of the glow on the left, right and the front of the thumb according to the formula:

R_{eff}= a (R_l +R_r+R_f)/3

Where the reduction numerical multiplier a (0<a<1) describes missing sectors of the discharge.

In the case shown in Fig. 5, a = 0.83 .

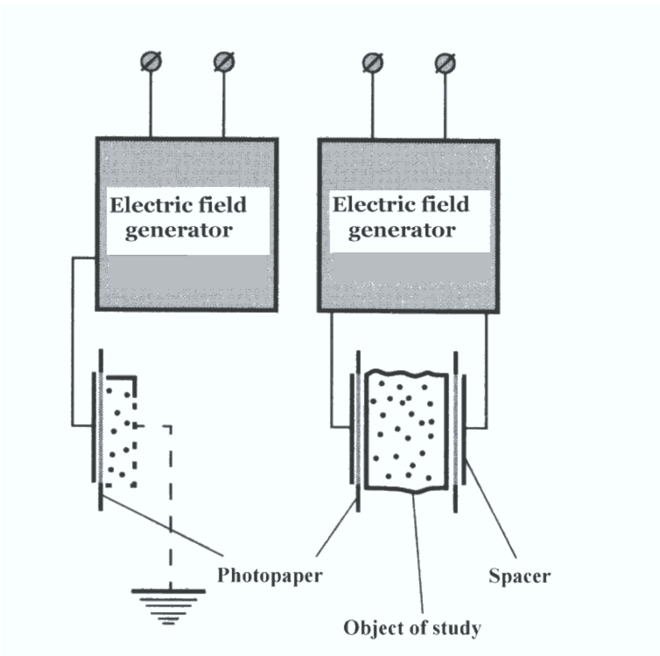


Fig. 2. Functional scheme of the gas corona discharge device

Fig. 3. Thumb placement on the transparent electrode

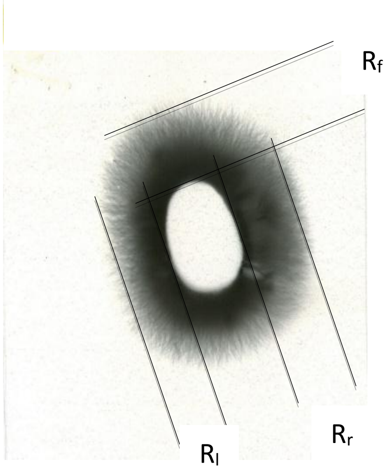


Fig. 4. Thumb coronal discharge measures

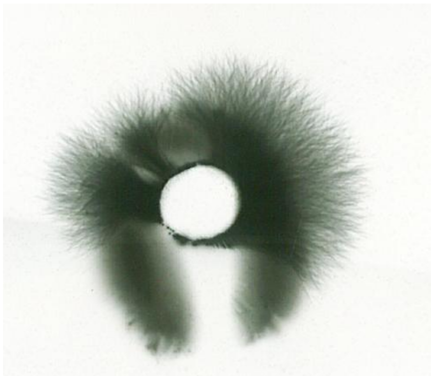


Fig. 5. Thumb coronal discharge with 17% missing sectors (corresponding to a = 0.83) .

2.2 Infrared Thermography

Infrared thermography in our study was performed in the middle infrared range from 8 µm to 14 µm allowing for measurement of temperaturesbetween 24.0 and 38.0 ^{0}C [14,18,19]. The first camera was Inframetrics/FLIR ThermaCam PM 290 wave type. FLIR ThermaCam PM 290, FLIR 390, Inframetrics PM 250 and Inframetrics PM 350 thermal infrared cameras were of FLIR short wave type, handheld, Focal Plane Array cameras that are capable of temperature measurements. These cameras stored images on a PCMCIA Card, and the images were further analyzed using one of several available FLIR software packages (Thermogram 95, FLIR Reporter 2000 Software, Researcher 2000). The second camera (D.I.T.I.) was a totally non-invasive clinical imaging camera for detection and monitoring of a number of diseases and physical injuries by revealing thermal abnormalities on the human body. It was used as a tool for diagnosis and prognosis, as well as for monitoring of treatment progress; the type of this device was TB 04 K. D.I.T.I. photographs were taken by Marin Marinov.

The skin temperature of a specific area around the eyes was measured after treatment (denoted by t_2).

It had been empirically proven that the critical temperature, below which there is no therapeutic effect, is 35,1°C.That is why, the difference $\Delta t = t_2 - 35{,}1$was used for characterization of bioelectromagnetic influence.

2.3 Visual Acuity and Measurements

For more than 20 years,research on bioelectromagnetic correction of amblyopia ("lazy eye"), hypermetropia (long-sightedness), myopia (short-sightedness), all of them appearing after prolonged use of glasses and contact lenses, has been successfully conducted [1].The author of the method is Ignatov.

Visual acuity (VA) characterizes the clarity of vision and is measured as the ability to precisely recognize small details. In this study, we applied a computer version of the Snellen test [20,21]. The measurements were performed by the ophthalmologist Parashkeva Tsaneva. For each experimental subject, the average change for both eyes from before and after bioelectromagnetic influence was calculated.

2.4 Experimental Group and Procedure

The experimental group consisted of 128 female and 218 male (altogether 336) subjects from 4 to 46 years of age, selected according to previous diagnosis of amblyopia, hypermetropia (long sightedness) or myopia (short sightedness). In the beginning, high-frequency corona discharge photographs of their right thumbs were taken, followed by infrared thermography and visual acuity (with and without correction) measurements of both eyes. Afterwards, bioelectromagnetic influence on both eyes was applied by the therapist placing both hands in front of subjects' eyes at a distance of approximately 2-3 cm. In the end, infrared thermography and visual acuity (with and without correction) measurements were repeated.

3. RESULTS AND DISCUSSION

3.1 Characteristics of Color Coronal Glow

Bioelectric activity in the human body influences the intensity of gas discharge glow [22,23,24]. And bioelectric activity itself is influenced by various kinds of pathology. This causal connection is reflected in the shape and color of gas discharge glow, which is characterized mainly by photon energy emission during electron transitions from higher to lower energy levels as a result of excitation by external electric field. Thus, for red color in the visible electromagnetic spectrum, this energy corresponds to 1.82 eV, for orange – to 2.05 eV, for yellow – to 2.14 eV, for blue-green (cyan) – to 2.43 eV, for blue – to 2.64 eV, and for violet – to 3.03 eV (Fig. 6). The reliable result threshold is $E \geq 2.53$ eV [1, 25-31].

The spectral range of the photon emission for the different colors is 380-495 nm and 570–750 nm±5 nm. Photons corresponding to green color emission were not being registered by the experimental setup in this study. In general, pathologies in the organism alter bioelectric activity which in turn reduces the apparent size of the gas discharge glow. This dependence was observed for many types of disorders, although statistically reliable results should further be obtained in order to possibly apply this method for medical diagnosis. For the purpose of this study, experimental subjects' contact area of the thumb with the transparent electrode was investigated.

3.2 Corona Discharge from Experimental Subjects

An energy threshold of photon emission was defined as 2.54 eV. Greater values correspond to normal bioelectrical status. In some cases of experimental subjects, values greater than 2.90 eV were measured. They were generally connected with practice of yoga, sports, etc. Values less than 2.53 eV were typical for subjects with reduced bioelectric activity. These results point to further opportunities of development and possible application of this method in biophysical studies [1, 13, 22].

Fig. 7 shows an example of normal emission (a) and another one after appendectomy (b).

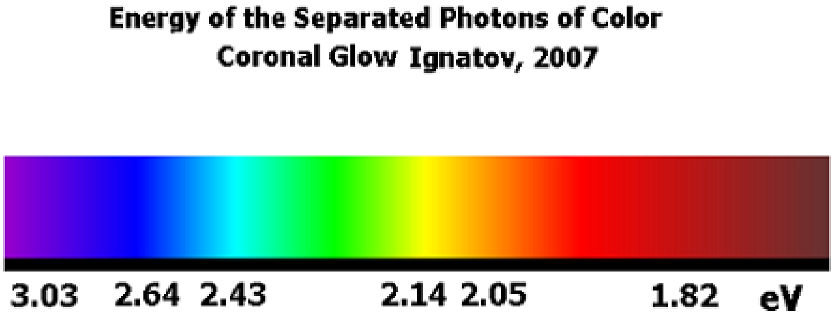
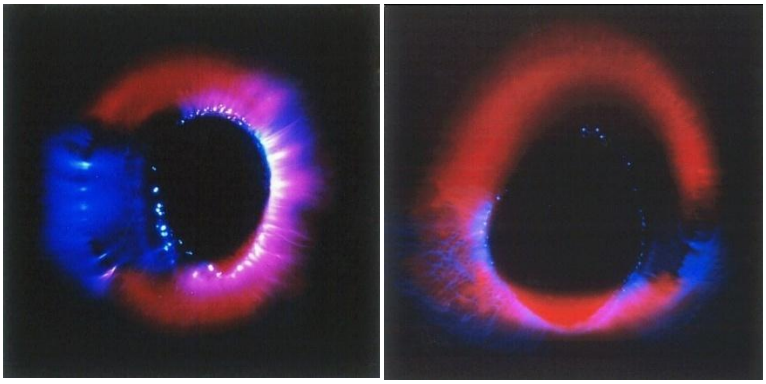
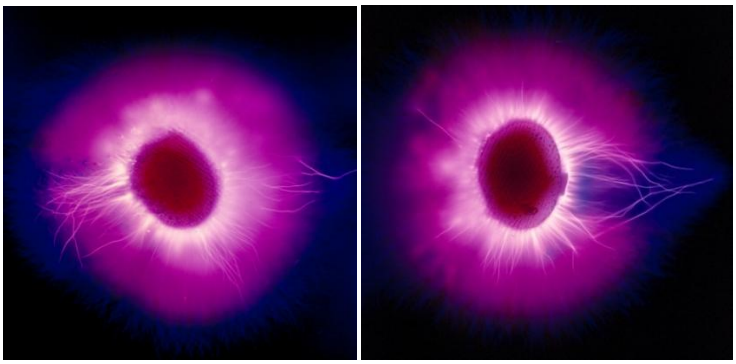


Fig. 6. Spectrum of color corona gas discharge emission



a b

Fig. 7. Examples of different types of emission: a) normal (2.51 eV) and b) after appendectomy (1.97 eV)



a b

Fig. 8. Photographs of higher bioelectrical activity displayed by Christos Drossinakis (a) (3.03 eV) and Bettina Maria Haller (b) (3.03 eV)

Fig. 8 illustrates two observed cases of higher bioelectrical activity: those of Christos Drossinakis (a) and Bettina Maria Haller (b) [22].

The objects of research were 1418 color bioelectric images. An analysis of the bio status depending on diseases was made. A computer program calculates the average energy in eV of the spectrum of bioelectric images. As an example in Fig. 7a is 2.51, and in Fig. 7 b is 1.97 eV. In Fig. 8 a is 3.03, and in Fig. 8 b is 3.03 eV.

The results from combined high-frequency coronal discharge, vasodilatation thermal effect and visual acuity (visus) measurementsfor corresponding numbers of experimental subjects are presented in Table 1.

Analysis of the correlation between the vasodilation thermal effect characterized by Δt and the average change of visual acuity leads to a correlation coefficient r=0.55-0.65 at a level of significance of p<0.01. Actually, there is causal connection between the infrared radiation emitted by the therapist and the physiological effect (vasodilation) taking place in the experimental subject. Moreover, this electromagnetic flux is sensed by both of them.

Statistical analysis was performed with Student's t-test for the visual analyzer characteristics before and after bioelectromagnetic influence. Concerning visual acuity (visus) without correction, there was distinct difference in both eyes t=6.0-6.7 at significance level p<0.001. The average visus improvement was 14.5%. In the cases of refraction amblyopia, the difference in both eyes with correction was t=6.7-7.1 at significance level p<0.001. The average visus improvement was 25.5%.It was shown with statistical F-analysis that the visus was influenced regardless of the type of vision disorder and the direction of energy flow. The results are valuable for the reason that a positive health effect was demonstrated for the most sensitive part of the eye – the retina. They additionally indicate that the human visual analyzer can function as a detector of biophysical fields. Achieved increase of visual acuity and reduced correction, verified with established ophthalmological methods, give objective evidence that bioelectromagnetic influence can improve human vision.

Concerning correlation between the temperature difference Δt and the effective width of the high-frequency corona discharge R_{eff}, it was found that r=6.0-6.7 at significance level p<0.001. The practical implication of this result is that high-frequency coronal discharge photography can be a reliable predictive method concerning outcomes of bioelectromagnetic influence on patients with vision disorders. Compared to infrared thermography, its application is much simpler and cheaper.

Table 1. Results from high-frequency coronal discharge, vasodilation thermal effect and visual acuity measurements for corresponding numbers of experimental subjects

Vasodilation thermal effect (°C)	Average change of visual acuity (without correction)	R_{eff} (mm)	Number of cases
Δt< 0	0.03	5.5	22
0 <Δt< 0.4	0.03	6.5	145
0.4 <Δt< 0.8	0.14	7.4	134
Δt> 0.8	0.49	9.7	35

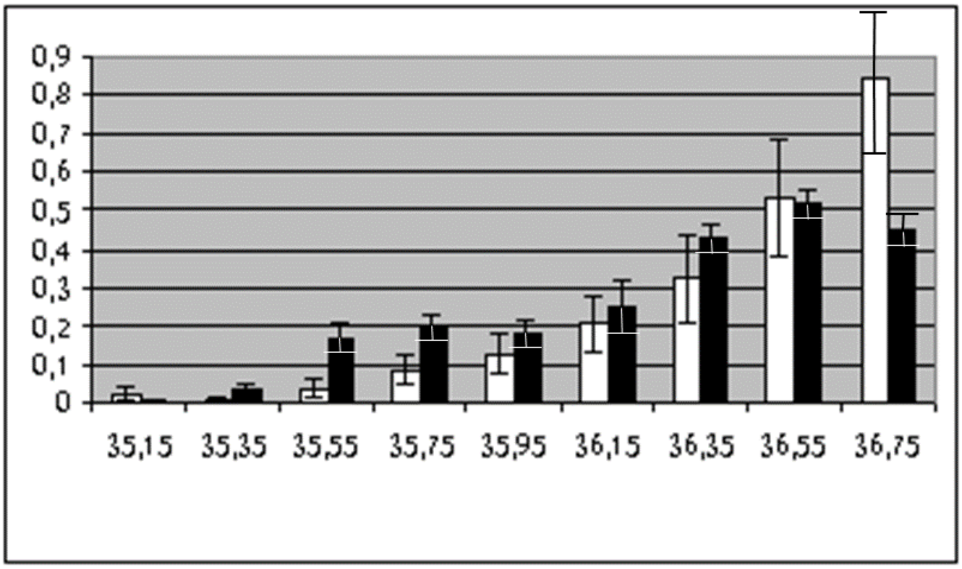


Fig. 9. Changes in the vision sharpness (visus) with and without correction due to the vasodilation effect as a function of temperature

The above results lead to a conclusion that about connection between the vasodilation effect and vision acuity (with and without correction). This connection is not linear (Fig. 9). The closer temperature variations are to 36,6 ^{o}C ($\Delta t = 1.5$) after bioelectromagnetic influence, the more distinct the effect is.

It is also worthwhile to elaborate on the connection between the vasodilation effect and changes in the visual analyzer.

In the rods and the flasks in the retina, light energy causes neural pulses. The size of the flasks anatomically determines the degree of vision acuity (Helmholtz). The diameter of a flask in the retina yellow spot is approximately 2.2 µm . In order to get a visual sensation of two separate points, it is required for their images to stimulate two flasks which are separated by a third, non-stimulated one.

Whenever the visual analyzer is under bioelectromagnetic influence, it produces a beneficial thermal vasodilation effect. When the biotherapeutic effect is strong and the temperature of the eye tissues is high, tears are observed.

The vasodilatory effect on a skin surface supplies with blood the capillary netting close to it. The blood stream is directed towards the middle vessel layer (choroid). The retina is better supplied with blood, which causes a positive effect on the decomposition and restoration of the vision-related substances in it. The photochemical reactions depend on the temperature of the medium. During bioinfluence, the stimulation of photochemical processes leads to improvement of the retinal bioelectric activity [7].

The dependence of the healing effect on the stage of the vision disorder (light, medium, heavy) was investigated. A distinct regularity was found with a coefficient of correlation r ranging from 0.35 to 0.45 at significance level $p<0.001$ that the influence efficiency was highest in light disorders and lowest in heavy disorders. This is a proof that the radiated electromagnetic energy flux has a definite power and the healing effect depends on that power.

Single-factor dispersion analysis was performed concerning age-related dependence of the healing effect in cases of visual disorders. For the three groups: 4-10, 11-21 and 22-49 years of age, we found that F=4.4-4.6 at significance level $p<0.01$. This analysis indicated that, at equal flux intensity of bioelectromagnetic influence, the eye tissue was influenced depending on the subjects' age and the healing results werehigher at younger ages.

4. CONCLUSIONS

Vision disorders are much more common in the modern world, mainly due to prolonged use of glasses and contact lenses. There are also other factors, such as long hours in front of computer screens, insufficient physical activity and unwholesome nutrition that attract more and more attention to efficient methods for maintenance and restoration of eye health. In the present work, we have demonstrated that biological electromagnetic radiation in the infrared range is capable of positive influence on a key vision characteristic, visual acuity, by producing a temperature-related vasodilation effect (verified with infrared thermography). Moreover, we found statistically significant correlation between the effective widths of high-frequency corona discharges from experimental subjects' thumbs, temperature increase in the eyes area and improvement of visual acuity. In general, higher positive results were associated with wider corona discharges and younger ages which is in line with the general principle that more efficient healing happens in organisms with better internal functioning.

Regarding future possibilities, we have demonstrated that infrared radiation of biological origin can be an efficient and safe healing factor, especially in the case of the eyes which are highly delicate, sensitive and vulnerable organs. Along these lines, it would be reasonable to conduct further research concerning similar health effects in other organs and systems.

In addition, high-frequency corona discharge photography can be additionally improved and applied both for diagnostics of overall functional status of patients and prediction of their healing dynamics.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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